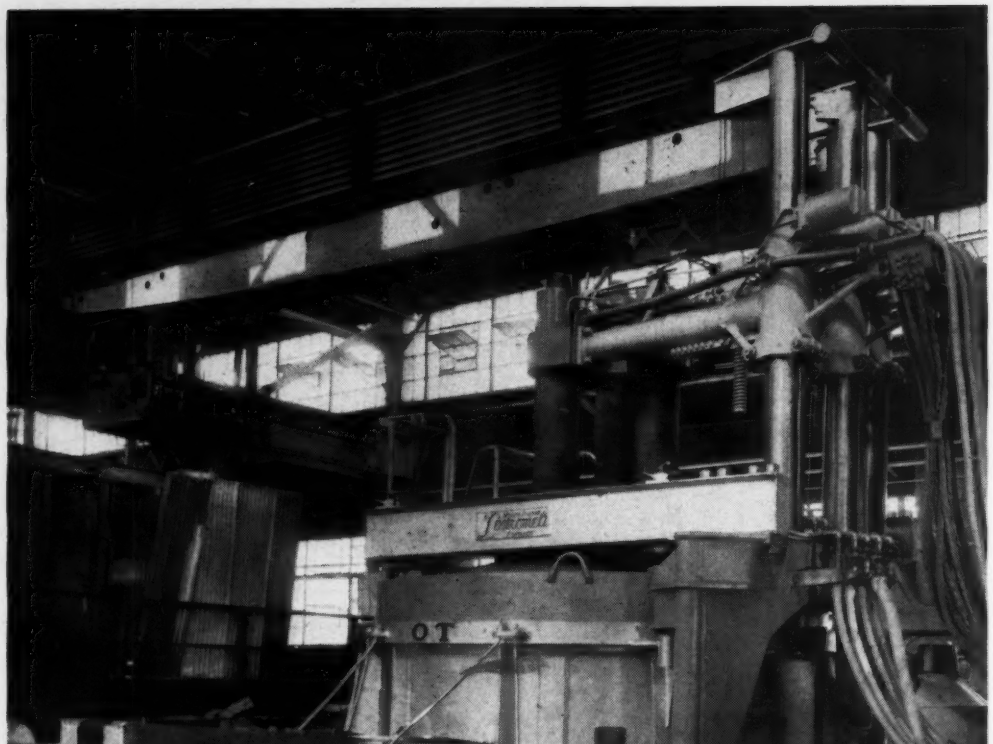
MAY 1948

AMERICAN FOUNDRYMAN

ST-CONVENTION ISSUE

THE FOUNDRYMEN'S Own MAGAZINE



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FOUNDRY ART BECOMES SCIENCE THROUGH RESEARCH

THE MAKING OF castings had its origin in ancient times. It is essentially an art which for many centuries has been handed down from generation to generation.

Artists of course create their work along individual lines, and it happens very seldom that any two of them will do the same thing in the same way. Artists treat materials in original ways. With the help of their own experience and from the training of a particular school of thought, they have been able to get around obstacles which otherwise might impair the desired fruit of their efforts—the finished product.

With the beginning of mass production, it was found necessary to sacrifice artistic individuality for industrial progress. Foundrymen began to add molding machines and other mechanical equipment in order to mechanize the foundry business. It was true, nevertheless, that the progress made toward better and more economical production was still based on the inherited experience of centuries of foundry practice. During the last world war, for example, it became quite evident that we are still lacking in basic knowledge of many problems which are troublesome to foundrymen.

It was only natural, therefore, that research projects should inevitably suggest themselves to the members of the American Foundrymen's Association. These projects were based on actual experience, and on an inventory indicating which facts were known, and which required further study and exploration.

The Research Committee of the Aluminum and Magnesium Division, after long and careful consideration, reached a fundamental conclusion. The Committee's finding was that little or nothing of basic knowledge is available on the fluid flow of metal in molds. It was indeed a refreshing experience to find a group of foundry experts candidly declaring the lack of fundamental knowledge on flow of metals in molds.

From such a start, it was not at all surprising that a research project in this field has since been planned with vigor and enthusiasm. At the Battelle Memorial Institute in Columbus, Ohio, the first coordinated investigations of this problem are now being ably undertaken. Certainly it is to the demonstrable advantage of all members of the Aluminum and Magnesium Division to support such a program with the full measure of their abilities. It is equally important for the whole American Foundrymen's Association to continue to support such research financially as vigorously as is presently evidenced.

This research project, of course, is not only for the benefit of the light metal foundries, but will be to the advantage of all foundries.

Many other similar research projects, equally fundamental in nature, are being carried on by the various Divisions of the American Foundrymen's Association. All of them are motivated by the same worthy objective: *to change the founding of metals from an art to a science.* Every member of the American Foundrymen's Association can be justly proud of this outstanding work in scientific research—and should welcome any opportunity to be instrumental in furthering this necessary evolution of the foundry industry.

Walter Bonsack

WALTER BONSACK, *Chairman*
Aluminum and Magnesium Division
AMERICAN FOUNDRYMEN'S ASSOCIATION

Walter Bonsack, assistant vice-president and director of laboratories, Apex Smelting Co., Cleveland, is chairman of A.F.A.'s Aluminum and Magnesium Division and a member of several of the Division's committees. Born in Berlin, Germany, in 1901, he received the degree of metallurgical engineer from the Technical College of Berlin in 1923 and was in the faculty from 1924 to 1927, when he came to the United States as director of laboratories for the National Smelting Co. Mr. Bonsack is a member of AIME, ASME, ASM, ASTM, SAE, and the Aluminum Research Institute, as well as A.F.A., and has written papers for technical meetings of most of these organizations and a number of books on aluminum alloys.

A. F. A. Convention News Story

Section of registration booth and part of the early crowd of convention attendants shortly after the A. F. A. 52nd Annual Convention opened.

Entrance to the exhibits and meeting rooms. In the background are A. F. A. Convention and Exhibits Manager A. A. Hilbron and C. E. Hoyt (facing camera), dean of American exhibit managers, and until 1946 in charge of A. F. A. exhibits.

Registration on both sides of the entrance hallway speeded A. F. A. members and guests on into the technical meetings and exhibits.

A. 52nd ANNUAL CONVENTION

HEAVIEST OPENING DAY CONVENTION ATTENDANCE in the history of the American Foundrymen's Association, marked the return of the Association to the City of its birth—Philadelphia—for the 52nd Annual A.F.A. Foundry Congress, May 3-7.

Nearly 15,000 foundrymen, metallurgists, and representatives from allied industries throughout the United States and from many foreign countries jammed Philadelphia's huge Convention Hall to hear authorities on the foundry industry and to witness the latest developments in foundry equipment, exhibited by more than 270 companies.

Highlights of the five-day Foundry Congress were the Charles Edgar Hoyt Annual Lecture, delivered by C. E. Nelson, Dow Chemical Co., at the Annual Business Meeting, May 5; and the Annual Banquet, held in the ballroom of the Bellevue-Stratford hotel, at which Dr. Karl Taylor Compton, president of the Massachusetts Institute of Technology spoke on *"Team Play of Hand and Brain."*

Technical sessions, held mornings and afternoons at Convention Hall and evenings at downtown Philadelphia hotels, covered every phase of foundry practice and included round-table luncheons, shop courses, the annual lecture course, educational forums and sessions on foundry costs, refractories, time study, plant equipment, and heat transfer. Exchange papers from England, Australia and France were featured during technical sessions on gray iron, brass and bronze, and malleable iron, respectively.

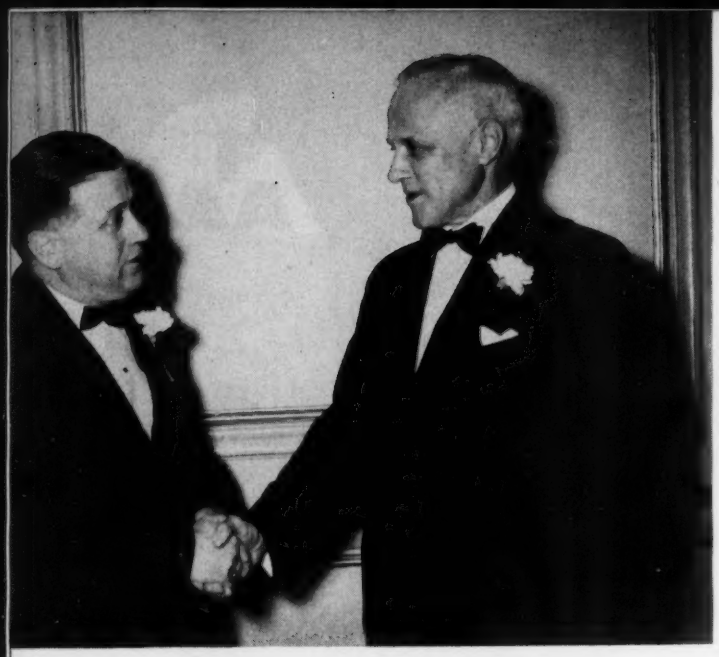
Well attended throughout the week, the exhibits and the technical meetings were crowded on May 4, Philadelphia Day, when Philadelphia foundrymen were admitted without charge by showing a special card. Visitations to plants in and near Philadelphia were made by many foundrymen who arranged trips through the Plant Visitation Committee at a desk in the A.F.A. Headquarters Booth.

The round of Convention social activities started with a reception Sunday, May 2, for A.F.A. President Max Kuniansky and Mrs. Kuniansky. National Officers and Directors, convention committee members, and their wives attended. Monday evening President Kuniansky played host to international visitors at a gathering attended by A.F.A. members and guests from Australia, Canada, England, France, Scotland, India, Norway, and Switzerland.

Tuesday evening President-elect W. B. Wallis, now Vice-President, presided at the Chapter Officers and Directors Dinner. The Canadian Dinner on Wednesday night was attended by members from the three Canadian chapters headed by National Director E. N. Delahunt, Warden King Ltd., Montreal. The A.F.A. Alumni Dinner Thursday was the traditional gathering of National Officers and Directors, Gold Medalists, and Honorary Life Members. This group heard Ivan H. Peterman, nationally known columnist and war correspondent for the *Philadelphia Inquirer,* discuss the recent elections in Italy.

The ladies entertainment program started with registration on Monday and carried on throughout the week. Included were a fashion show and tea, a tour of historic central Philadelphia, a visit to the Franklin Institute, and a trip to Valley Forge. Ladies entertainment activities were climaxed by the Annual Banquet and dance which followed.

The Annual Banquet, held on May 7 at the Bellevue-Stratford hotel, was the occasion for presentation of three A.F.A. Gold Medals and the address *"Team Play of Hand and Brain,"* by President Compton, Massachu-



A.F.A. President Max Kuniansky (left) greeting Dr. Karl T. Compton, president, Massachusetts Institute of Technology, who spoke at the Annual Banquet of the 52nd A.F.A. Foundry Congress and Show.

setts Institute of Technology. Dr. Compton reviewed the discovery of the electron, of radioactivity, and of x-rays. In discussing the development and production of artificially radioactive materials he cited metallurgical and medical uses of radioactive isotopes. In conclusion, Dr. Compton pointed out that research and development pay off, and that the practical techniques of production and instrumentation must team with theoretical techniques for their mutual success.

The Annual Banquet was opened by National President Kuniansky who read a cablegram of greetings from P. H. Wilson, president of the Institute of British Foundrymen. Location of the A.F.A. Convention for 1949—St. Louis—was announced.

Presentation of Awards

Egbert H. Ballard was presented with the William H. McFadden Gold Medal by James L. Wick, Jr., also a Past-President, for his *"steadfast and sincere efforts in behalf of the Association while serving as its president during most difficult times, and his continual contributions to the foundry industry throughout his business career."*

R. G. McElwee received the John A. Penton Gold Medal for *"outstanding contributions to the dissemination of information to the foundry industry, especially for his splendid efforts on behalf of the Cupola Research Project."* Presentation of the medal was made by Past President Fred J. Walls.

Peter E. Rentschler (right), Hamilton Foundry & Machine Co., Hamilton, Ohio, receiving the Peter L. Simpson Memorial Medal from Past Director Walter L. Seelbach, Superior Foundry, Inc., Cleveland.

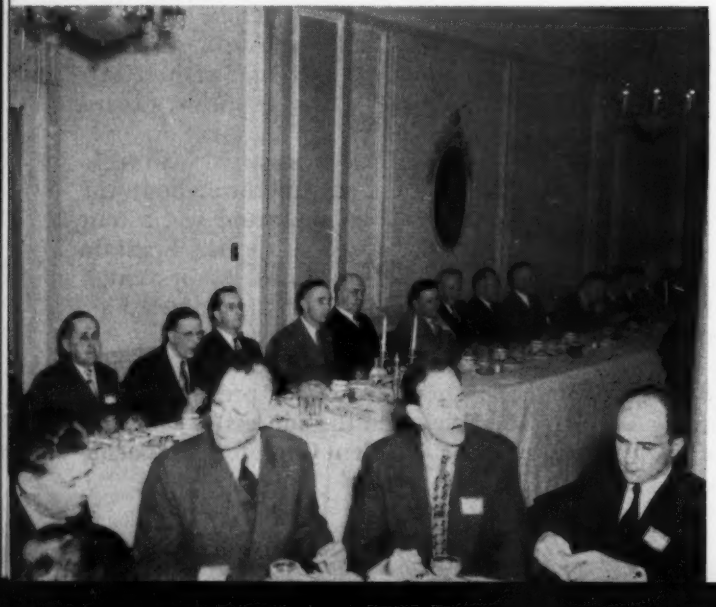
Peter E. Rentschler was presented the Peter L. Simpson Memorial Medal for his *"outstanding work in promoting better housekeeping and safety practices in the foundry and for the inspiration he has given the foundry industry in the field of public relations."* Walter L. Seelbach presented the medal.

As retiring head of the Association, Max Kuniansky received a certificate of honorary life membership from Immediate Past President S. V. Wood.

Annual Meeting

Feature technical paper of the 52nd Convention of A.F.A. was the Charles Edgar Hoyt Annual Lecture, *"The Control of Grain Size in Magnesium Castings,"* by C. E. Nelson. Presented at the Annual Meeting the morning of May 5, Mr. Nelson's paper followed a report on the election of officers for 1948-49, the presentation of Apprentice Contest awards, a message from the Institute of British Foundrymen, and a talk on foundry educational activities. President Max Kuniansky presided.

Report on the election was made by Secretary-Treasurer Wm. W. Maloney, who stated that the nominees previously reported had been duly elected in accordance with the By-Laws.* He announced the winners of the 1948 Apprentice Contest and presented the four first prize winners (see pages 52-54) to President Kuniansky. In awarding the certificates and $100 prizes,



Canadian Dinner with National Director E. N. Delahunt, Warden King Ltd., Montreal, presiding, and National Officers and Directors, and representatives of the three Canadian chapters at the head table.

* Pictures and biographical sketches of new officers and directors are on pages 50 and 51.

R. G. McElwee, Vanadium Corp., Detroit (left) receiving the John A. Penton Gold Medal from Past President F. J. Walls, International Nickel Co., at the 14th conferral of this A.F.A. award.

Egbert H. Ballard, retired, President of A.F.A. in 1931-32 (right), accepting the William H. McFadden Gold Medal from Past President James L. Wick, Falcon Bronze Co., Youngstown, Ohio.

Mr. Kuniansky paid tribute to the apprentices and their companies for their continued interest in one of the most important phases of foundry education.

British Foundrymen Send Greeting

E. Longden, P. R. Jackson & Co., Ltd., Manchester, England, expressed the compliments and good wishes of the Institute of British Foundrymen and its president, P. H. Wilson. World progress, he said, is measured by progress in the United States, and he hoped that the system of government which makes such progress possible will continue and prosper.

Educational Division Chairman F. G. Sefing, International Nickel Co., commented on educational activities of the Association and of the Foundry Educational Foundation. Personal efforts of foundrymen are essential to the success of these programs, he said, insisting that large sums of money are not, in themselves, adequate. A.F.A. chapter groups to promote the five-point "new blood" program will be formed soon, he added.

Hoyt Speaker Discusses Magnesium

Grain size control is fundamental in all cast metals, C. E. Nelson said at the start of the Charles Edgar Hoyt Annual Lecture. In general, finer grain size gives higher mechanical properties, although a coarse grain is preferred where creep resistance is an important factor. Hot cracking is at a minimum in fine grained alloys and better machined finishes result, especially where heavy cuts are taken. A fine grained alloy is easier to solution heat treat.

Vice-President W. B. Wallis, Ivan H. Peterman, Philadelphia Inquirer, and President Max Kuniansky (l. to r.) discussing Mr. Peterman's experiences in the recent Italian elections before the Alumni Dinner.

Alloying of pure magnesium reduces the grain size, according to Mr. Nelson, and faster cooling reduces it still further. Prevention of germination which causes rapid grain growth during homogenizing heat treatments calls for a variety of precautionary measures. Grain refining procedures were described and illustrated with slides of the microstructures produced. The extreme grain coarsening effect of constituents such as beryllium and the influence of manganese in preventing germination were brought out.

Methods of grain refining are: (1) superheating at 300 to 500 F above the melting point of the alloy; (2) treating with carbon or carbonaceous solids, liquids, or gases; (3) violent agitation at 1400 F or above, especially in combination with carbonaceous treatments; (4) treatment with anhydrous ferric chloride, effective only if manganese is present.

Explains Grain Refinement Theories

In discussing theories advanced to explain grain refinement of magnesium alloys, Mr. Nelson discounted the "liquid crystal" theory, and also showed that the effect of magnesium oxide nuclei is minor. Explaining that the surface tension hypothesis requires further development, he said that the temperature-solubility nucleation theory is currently most widely accepted but fails to explain anomalous behavior of normal casting alloys on remelting and superheating.

An explanation based on laboratory work previously not reported was substantiated with slides showing re-

Thomas D. Craven, Howard Foundry Co., Chicago, explaining the finer points of his casting—the first magnesium entry to win the top award in the nonferrous division in the twenty-five year history of the A.F.A. Annual Apprentice Contest.

Officers and Directors of the American Foundrymen's Association and its chapters got better acquainted at the Chapter Officers and Directors Dinner, May 4.

sults obtained by electron microscope and by microradiography. The latter disclosed the presence of stars, needles, and crosses in alloys showing coarsened grains. Electron diffraction pictures of the various phases indicated that grain refinement was related to a temperature dependent phase of hexagonal crystal habit.

In summarizing the significance of the preliminary laboratory studies reported, Mr. Nelson concluded that there is definite evidence of phase changes in magnesium alloys that correspond to the known thermal and grain refining treatments, and that the phases present when grain refining is known to take place are favorable to nucleation. Conversely, when coarsening is taking place the favorable nucleating phases are disappearing and unfavorable phases are taking their place. It was further concluded that a temperature-phase relationship theory goes much farther in explaining the entire grain refining mechanism than other current theories.

SAND

The first of the Sand Division's two major technical sessions was held on the afternoon of May 5, with C. W. Briggs, Steel Founders' Society of America, presiding in the absence of Chairman E. C. Troy. Werner Finster, American Chain and Cable Co., acted as co-chairman of the session.

More than 200 members and visitors heard Harry W. Dietert, Harry W. Dietert Co., speak on *"Surface Gas Pressure of Molding and Core Sands."* Mr. Dietert cited an experiment wherein gas pressure was determined by ramming a brass tube into a core.

Since the tube extended to within 1/8 in. of the surface of the core, the gas pressure 1/8 in. from the outer surface could be measured, using a pressure gauge. The core specimens were immersed in a lead bath at 1200 F. Gas pressure was found to increase proportionately with the increase of cereals, moisture, sea coal, or oil. It was also found, Mr. Dietert said, that extremely high mold hardness and differences in baking time affected gas pressures in cores.

J. B. Caine, Sawbrook Steel Castings Co., chairman of the A.F.A. Mold Surface Committee, presented a report on *"The Changes in Chemistry of Liquid Steel in Contact With Sand."* The Mold Surface Committee, Mr. Caine stated, has concluded that oxidation and decarburization resulting from the contact of steel and sand are due to a reaction with mold gases, of which dissociated water vapor is the most chemically active.

Scaling during heat treatment should remove decarburized surfaces automatically in most instances, Mr. Caine added. Volatilization and oxidation can be discounted as mechanisms of penetration of steel. He concluded that low sand content of penetrated steel and sand accentuates the role of pure mechanical penetration as the cause of adhering sand.

The May 6 sand session, held under the chairmanship of J. A. Rassenfoss, American Steel Foundries, was attended by approximately 100 foundrymen. E. C. Zirzow, National Malleable and Steel Castings Co., served as co-chairman.

P. E. Kyle of Cornell University discussed reproduceability, hot compression strength versus temperature for typical foundry mixes, and preliminary tests working toward a compilation of molding sand standards in his *"Progress Report on High Temperature Properties of Steel Molding Sands."*

Urges Standard Strainer Cores

Following Professor Kyle's report, H. L. Campbell, Western Foundry Co., spoke on *"Strainer Cores."* Mr. Campbell proposed that that vast number of shapes and sizes of strainer cores now in use be reduced to seven. Selection of those seven standard strainer cores, he said, should be based on metal delivery rates.

Harry W. Dietert, Harry W. Dietert Co., chairman of the A.F.A. Committee on Physical Properties of Iron Foundry Molding Materials at Elevated Temperatures, reported on the Committee's study of the *"Cause of Rat-Tail Casting Defects."*

Two properties of sand appear to be direct causes of rat-tails—expansion at 1000 F and hot strength at 1000 F—Mr. Dietert said. Sands with high hot strength and high expansion produce more rat-tails. It was suggested that the use of controlled amounts of combustible materials in sand mixtures would help to eliminate rat-tails.

The first of the Sand Shop Courses, held the evening

of May 3 at the Bellevue-Stratford hotel, had as its chairman R. F. Thomson, International Nickel Co., with C. A. Sanders, American Colloid Co., as co-chairman. J. J. Shannon, Jenkins Bros., led the discussion on *"Non-Ferrous Foundry Sands,"* in which careful planning of sand control before considering foundry mechanization was stressed.

D. F. Sawtelle, Malleable Iron Fittings Co., presided at the May 4 Sand Shop Course. A discussion on *"Malleable Foundry Sands,"* led by R. P. Schauss, Illinois Clay Products Co., included such topics as grain fineness, A.F.A. clay, bonds and grain distribution. It was stressed that sea coal not only improves casting finish, but maintains sand volume in the system.

T. W. Curry, Lynchburg Foundry Co., led some 150 members in a discussion on *"Gray Iron Foundry Sands"* at the May 5 Sand Shop Course meeting. E. L. Thomas, Cadillac Motor Car Co., was chairman and N. J. Dunbeck, Eastern Clay Products Co., co-chairman.

Topics included in the discussion were: synthetic sand, sand handling, testing, the use of mold hardness testers on the foundry floor, and the training of sand testers and muller operators so as to enable them to take over each other's jobs when necessary.

At the final Sand Shop Course meeting, held the evening of May 6, D. F. Sawtelle again presided, in the absence of both Chairman R. H. Jacoby, Key Co., and Co-Chairman E. E. Woodliff, Foundry Sand Service Engineering Co. Charles Locke, Armour Research Institute, led a discussion on *"Steel Foundry Sands."*

STEEL

The program of the Steel Division, concentrated on May 6 and 7, featured three technical sessions, a round table luncheon, and an Annual Lecture Course session.

Opening the program on the morning of May 6, 150 persons heard *"Observations on Knock-Off Risers as Applied to Steel Castings,"* introduced by S. W. Brinson and presented by J. A. Duma of the Norfolk Navy Yard. Mr. Brinson, in introducing the paper, said he felt that too many foundrymen were guilty of "wishful thinking" insofar as foundry techniques are concerned, and cited the case of knock-off risers particularly. There is a great need for better fundamental grounding in this phase, he said.

Riser Test Results Outlined

Among the conclusions drawn by Mr. Duma were: knock-off risers with circular neck sizes greater than 2⅜ in. in diameter will not knock-off when hit with manually-powered mauls; and that maximum depth of casting which can be fed with open knock-off risers appears to be 6 in., 8 in., 8 in., and 8 in., respectively, for 2 in., 4 in., 6 in. and 8 in. diameter billets. The authors were unsuccessful in making sound 10 in. diameter billets using cores ½ in. to 1½ in. thick with holes from 1½ to 2½ in. in diameter. In this connection, Mr. Duma added, tests are in progress using cores made of plastic fire brick.

In discussing Messrs. Brinson and Duma's paper, E. C. Troy, representing National Engineering Co. and Foundry Equipment Co., complimented the authors on their fundamental research into knock-off riser problems, and pointed out that the proper proportioning of core thickness to neck diameter requires understanding of heat transfer relationships. J. B. Caine, Sawbrooke Steel Castings Co., pointed out that a larger neck diameter is required if the core is rodded.

"A Theoretical Approach to the Problem of Dimensioning Risers" was presented by Mr. Caine as the concluding address of the session. In his paper he suggested a means of mathematically dimensioning risers, dependent upon the relationship of volume and relative freezing rate.

A written discussion of Mr. Caine's paper, submitted by Dr. H. A. Schwartz, National Malleable & Steel Castings Co., and read by W. K. Bock of the same company, cited both advantages and disadvantages found in Mr. Caine's data. The fact that the adequacy of a feeder could be determined from the dimensions of a given casting and feeder, regardless of any limitation of shape, was cited by Dr. Schwartz as a decided advantage. However, he said, the disadvantage is that, given only a description of the casting, the calculation of a feeder is a matter of trial and error and there is no guide to the selection of the most efficient feeder form.

Seven of the past presidents of the Wisconsin Chapter of A.F.A. photographed in the booth of the Foundry Educational Foundation. FEF Executive Director G. K. Dreher is in the center.

President Max Kuniansky congratulating Adolph Scanzoni, Continental Foundry & Machine Co., Chicago, following presentation of award for the best steel casting in the 1948 Apprentice Contest.

He added that Mr. Caine's reasoning does not include a consideration of heat transfer across the feeder and casting. This, he said, must exist to some extent because the casting must cool faster than the feeder in order to have the feeder function.

Gating Systems Film Shown

Following this session, the Steel Round Table Luncheon was held with J. A. Duma and J. A. Rassenfoss, American Steel Foundries, as co-chairmen.

William H. Johnson and William O. Baker of the Naval Research Laboratory, Washington, D.C., presented a motion picture, *"Gating Systems for Metal Castings,"* following the luncheon, with Mr. Johnson providing the narrative. The experiments shown in the film brought out the fact that the behavior of gating systems is not well understood and that many of the systems do not function as commonly supposed.

At the Annual Lecture Course session, held the afternoon of May 6, Discussion Leader J. W. Juppenlatz, Lebanon Steel Foundry, spoke on *"Test Procedures for Quality Control of Steel Castings,"* in which he stressed that proper design of castings should be the first thing considered in quality control. The pattern equipment must be properly made, he said, and gating, pouring, and heading control is essential. Castings must be proven before production and pattern equipment must be checked for wear. Raw materials must conform to specifications for quality and uniformity, he added. G. A. Lillieqvist, American Steel Foundries, was chairman of the session, and C. H. Lorig, Battelle Memorial Institute, co-chairman.

Tensile Properties Discussed

Three papers were presented at the Friday morning steel session, presided over by Frank Kiper, Ohio Steel Foundry, and V. E. Zang, Unitcast Corp.

Speaking on *"Tensile Properties vs. Composition of Double Normalized Cast Steel,"* W. K. Bock, National Malleable & Steel Castings Co., co-author of the paper with Dr. H. A. Schwartz of the same company, described an empirical equation for calculating tensile strength of double normalized cast steel from its chemical composition.

S. L. Gertsman explained the *"Delayed Quench for Steel Castings"* in the second address of the session. The process, he said, involves austenizing at temperatures usually employed, a timed cooling and a quench in water, followed by a draw to produce the required mechanical properties. He added that a considerable saving of furnace time is effected over the normalize-reheat-quench-and-draw procedure, at a sacrifice of no mechanical properties. However, the process is recommended only where volume production is involved.

In describing the *"Electro-Chemical Cleaning of a Large Steel Casting—An Experiment,"* J. A. Wettergreen, General Electric Co., described a successful experiment to determine the possibilities of removing fused sand and oxides from the interior of a large cast steel turbine shell with the use of an electrolytic molten caustic bath.

The last steel session, held on the afternoon of May 7, had as its co-chairmen, J. F. Randall, Ford Motor Co., and D. C. Zuege, Sivyer Steel Castings Co.

Explains Statistical Quality Control

"Statistical Quality Control—A New Tool for the Foundryman" was the subject of a paper by H. H. Johnson and G. A. Fisher, National Malleable & Steel Castings Co., presented by Mr. Johnson, who outlined the principles underlying statistical methods used in measurement and control of the quality of castings as applied to foundries producing steel castings.

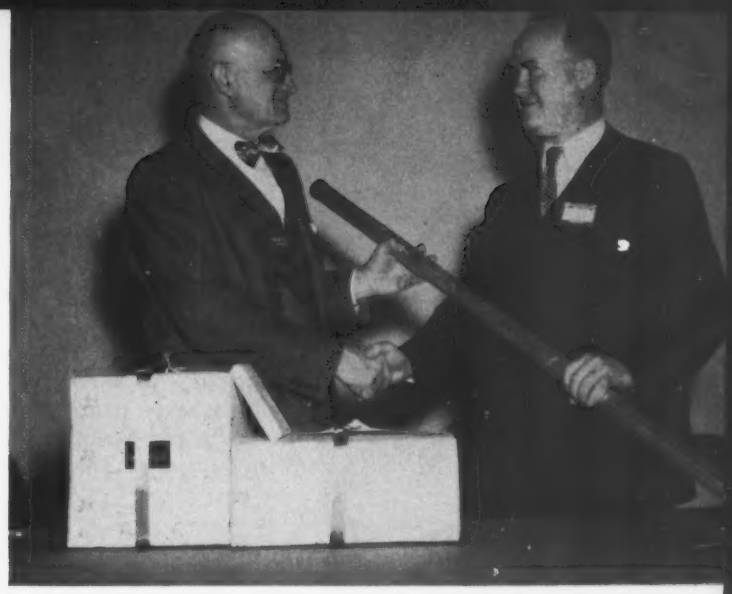
J. D. Wozny, American Steel Foundries, co-author with E. LaGrelius of *"Techniques of Quality Welding of Plain Carbon Steel Castings,"* explained the purpose of a study to develop welding techniques to produce welds which are sound and possess the minimum properties required of plain carbon steel castings. The authors further studied the metallurgical effects of the size of a weld, section-size welded, and subsequent heat treatments on the hardness and microstructure. Mr. Wozny pointed out that it was found that mineral or lime-coated electrodes generally produce sound welds free from pinhole porosity.

The Chapter Officers and Directors Dinner gave chapter representatives ample opportunity to exchange ideas on chapter operations and activities.

Exhibitors were busy throughout the 52nd A.F.A. Foundry Congress and Show handling crowds of foundrymen interested in seeing the latest developments in foundry equipment and supplies.

C. E. Nelson, Dow Chemical Co., Midland, Mich., received equipment for fly fishing from Annual Lecture Committee Chairman H. Bornstein following presentation of the Charles Edgar Hoyt Annual Lecture.

The Steel Round Table Luncheon, like the luncheon meetings of other divisions, was well attended and provided opportunity for off-the-record discussion.



MALLEABLE IRON

The Malleable Division program for the 52nd Foundry Congress comprised three technical sessions, a Round Table Luncheon, and an Annual Lecture Course meeting. The program was scheduled for the first and second days of the Convention, May 3 and 4.

Opening the malleable iron program at a technical session on the morning of May 3, W. K. Bock, National Malleable & Steel Castings Co., co-author with Dr. H. A. Schwartz, presented *"Effect of the Common Alloying Elements on the Tensile Properties of Malleable Iron."*

Mr. Bock stated that effects of alloying elements are obscured by other operating variables and that deductions therefore are generally believed to be inconclusive. Any alloy dissolving in ferrite strengthens it, he said, and the effects of successive increments in the concentration of a given element are not directly additive but decrease as the total alloy increases.

However, he added, the effects of several alloys can be approximated by converting all into equivalent amounts of a single alloy. Silicon seems to exert an effect on graphite form which may obscure its effect in the matrix, he concluded.

Recommends Oil-Fired Furnace

"The Construction and Operation of an Oil-Fired Malleable Iron Holding Furnace" was described by F. Coghlin, Jr., Albion Malleable Iron Co., who explained the design and operational details of a furnace used in a duplex system.

Mr. Coghlin compared the oil-fired furnace with the coal-fired furnace, and described in detail the refractory layout, the oil burner system, atmosphere control system, and operating methods and data used in the oil-fired furnace. He cited the following advantages to be derived from use of the oil-fired furnace: lower fuel preparation costs, lower fuel costs, lower refractory and refractory maintenance costs, ability to hold greater furnace tonnages, improved iron analysis control through atmosphere control, less maintenance of fuel supply equipment, and more uniform operation.

French Exchange Paper

Presentation of the Exchange Paper of the French Foundry Technical Association, *"Influence of Chromium on Graphitization of White Cast Iron,"* by Gabriel Joly, Foundry Industry Technical Center, Paris, was made by C. O. Burgess, Union Carbide & Carbon Research Laboratories, Inc., at the session.

According to Mr. Joly, chromium in white cast iron retards graphitization. Less than 0.002 per cent boron in the iron does not influence the rate of decomposition of carbides in the first stage of graphitization. However, it was brought out, chromium reduces the time needed to decompose pearlite.

C. F. Lauenstein, Link-Belt Co., presided at the session, and W. D. McMillan, International Harvester Co., served as co-chairman.

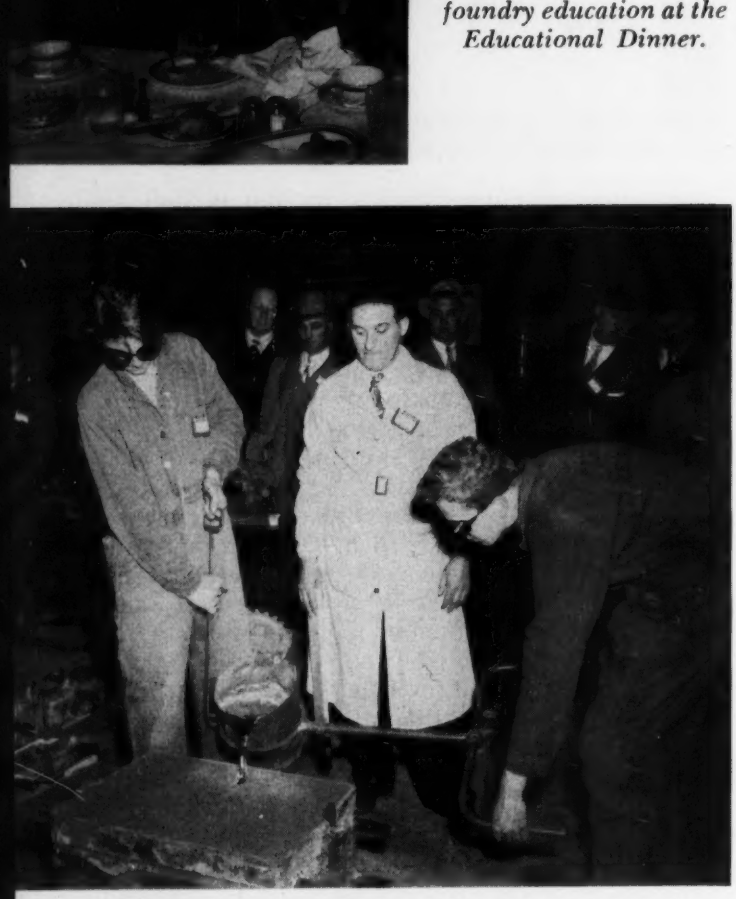
At the May 3 afternoon session, R. G. Seidel, National Malleable & Steel Castings Co., addressed more than a hundred foundrymen on *"Applications of Correlation in the Malleable Iron Foundry"* in which he outlined the possibilities of correlation techniques in the foundry. His discussion, Mr. Seidel said, was not designed to be a complete treatise on the subject, but rather to serve as a tool in judging a situation.

Discusses Hardness Testing

C. Schneider, National Malleable Castings Co., in presenting a paper he co-authored with L. Ulsenheimer of that company, *"Production Hardness Testing in a Malleable Shop,"* discussed two methods for measuring Brinell hardness of pearlitic malleable castings. The first of these involves applying the Brinell load of 3000 kg through a 10 mm ball, manually or automatically. The diameter of the impression made in the casting is then measured with a Brinell microscope and converted to Brinell hardness number.

In the second method the hardness is determined by means of a direct reading machine, first by applying a 1500-kg pre-load, resetting the dial to zero and then applying the full 3000-kg load. The dial on the machine then indicates the hardness of the casting, Mr. Schneider said, and stressed that constant checking of the machine with direct calibration is necessary. C. F. Joseph, General Motors Corp., presided at the session, and Eric Welander, Union Malleable Iron

M. J. Gregory, retired, former foundry manager for Caterpillar Tractor Co., Peoria, Ill., pointed out management's responsibility in foundry education at the Educational Dinner.



Operations in the Murrell Dobbins Vocational School booth were Foundry Instructor Edward Saks who also acted as Contest Judge.

One of the youngest visitors at the Show enjoyed the exhibit of the Philadelphia Naval Shipyard.

Works was co-chairman at this malleable session.

Opening the second day's technical session, J. E. Rehder, Canadian Bureau of Mines, spoke on the *"Effect of Manganese-Sulphur Ratio on the Rate of Anneal of Blackheart Malleable Iron."* Mr. Rehder stated that he had cast two sets of test bars to find the ratio of manganese to sulphur in white cast iron suitable for making blackheart malleable iron.

One series, he said, contained 0.09 per cent sulphur, and the other 0.21 per cent sulphur, with other constituents in normal proportions. Minimum first and second stage isothermal annealing times were determined for each bar and the results plotted against manganese-sulphur ratio. He showed that pronounced minima were produced in second-stage annealing times by a suitable ratio, with less effect on first-stage times.

With higher sulphur content, Mr. Rehder added, the minimum is in a narrower range of manganese than with low sulphur content. This indicates, he concluded, that better control of manganese content is important commercially in high-sulphur white irons.

Richard Schneidewind, University of Michigan, in presenting *"Pearlitic Malleable Irons, Plain and Alloyed,"* which he co-authored with D. J. Reese of the International Nickel Co., explained the influence of microstructure on the mechanical properties of ferritic and pearlitic malleable irons, plain or alloyed.

Mr. Schneidewind stressed the relationship between design strength and toughness as measured, respectively, by the yield point and the elongation. There is danger of stabilizing massive carbides with some alloys, he concluded, and of producing primary graphite by inoculation with others. G. A. Vennerholm, Ford Motor Co., was chairman of the session, and W. B. McFerrin, Electro Metallurgical Co., co-chairman.

More than 100 foundrymen attended the Malleable Division Round Table Luncheon, following the morning session, and heard R. J. Anderson, Belle City Malleable Iron Co., speak on *"Malleable Foundry Mechanization."* J. H. Lansing, Malleable Founders' Society, and A. M. Fulton, Northern Malleable Iron Co., were chairman and co-chairman, respectively.

Speaking at the Annual Lecture Course meeting, M. O. Booth, General Motors Corp., in his address, *"Test Procedure for Quality Control of Malleable Iron Castings,"* covered the practices in the control of quality of malleable iron castings, and the means of producing quality castings at the lowest possible cost. H. N. Whitmore, National Malleable & Steel Castings Co., presided at the lecture, with Milton Tilley, of the same company, as co-chairman.

EDUCATION

A technical session, featuring a Recruiting and Training Panel, an address by G. K. Dreher of the Foundry Educational Foundation, an Educational Dinner, and the Engineering School Graduates' Luncheon, made up the program of the Educational Division at the 52nd Annual Foundry Congress.

Speaking on *"Engineering Education for the Foundry Industries"* at the opening session on the morning of May 3, G. K. Dreher stated that U. S. foundries employ some 475,000 men. Assuming that only one employee in 25 has management status, there are 19,000 such positions at the present time. If only 10,000 of

these are engineering graduates the foundry industry is confronted with the problem of supplying a constant stream of engineering replacement personnel. It is up to the industry, Mr. Dreher said, to provide requisite training for these men and to support their education.

The training in present techniques is the responsibility of industry, he stated. The desires of the foundry industry along educational lines must be unified into a single basic concept. When this is accomplished, educators will make every effort to develop curricula to create a more adequately balanced personality in graduate engineers. To this end, Mr. Dreher suggested the addition of social humanics studies, industrial administration and human engineering to present day engineering courses. Written discussions of Mr. Dreher's paper were submitted by Prof. G. J. Barker and by Dean M. O. Withey of the University of Wisconsin.

Several questions were asked from the floor as to what the Foundry Educational Foundation and the American Foundrymen's Association planned to do regarding the promotion of apprentices to college training. Interest was particularly evident in questions concerning the need for craftsmen in foundries.

Recruiting and Training Panel

Mr. Dreher's address was followed by a Recruiting and Training Panel composed of G. J. Barker, University of Wisconsin, A. W. Gregg, Whiting Corp., H. L. Rosse, Eddystone (Pa.), Borough Schools, F. B. Skeates, Link-Belt Co., and R. S. Tour, University of Cincinnati.

Sixty-five persons attended the Educational Dinner, held at the Benjamin Franklin hotel on May 3. Following the dinner, A. W. Gregg, presiding, introduced M. J. Gregory, retired, formerly of Caterpillar Tractor Co., who spoke on *"Management's View of Foundry Educational Activities."*

Mr. Gregory prefaced his remarks by stating that management is to blame for not inspiring young men to enter foundry work. This was disputed by Mr. Dreher, who pointed out that the Foundry Educational Foundation was started by management and is believed to be doing a fine job along college educational lines.

D. F. Lane, co-chairman of the dinner session, added that his organization, Bethlehem Steel Co., recently instituted a summer-job program and has asked for applicants from college engineering students. G. J. Grott, chairman of the Massachusetts Institute of Technology Student Chapter, explained his reasons for entering MIT's foundry option course.

An address by Prof. R. M. Brick of the University of Pennsylvania at the Engineering School Graduates' Luncheon, "Engineering Education," aroused considerable comment when Prof. Brick stated that, in his opinion, the reason why so few colleges include foundry courses in their curricula is attributable to lack of funds whereby qualified instructors might be secured at salaries commensurate with at least a Ph.D. degree.

H. H. Judson, Minneapolis-Moline Power Implement Co., presided at the luncheon, with C. V. Nass, Pettibone-Mulliken Corp., acting as co-chairman.

PLANT AND PLANT EQUIPMENT

Lester B. Knight, Lester B. Knight & Associates, was the speaker at the single technical session of the Plant and Plant Equipment Committee, held the evening of

Attendance at the Brass and Bronze Round Table Luncheon was so great it was necessary to place diners at the speakers' table behind the head table.

Pictured here with National President Max Kuniansky and President-Elect W. B. Wallis are a few of the many foundrymen from overseas who attended the Foreign Visitors' Reception, held May 3.

Old timers renewed old acquaintances and registered at the booth near A.F.A. Convention Headquarters where they received pins recognizing service of 25 and 50 years in the foundry industry.

May 4 at the Bellevue-Stratford hotel. Speaking on *"Modernization of the 'Small' Foundry,"* Mr. Knight stated that no foundry can afford not to modernize and provide good working conditions. In a modern foundry, he said, maximum units are produced with adequate returns to both labor and management.

Mr. Knight cited as factors to be investigated in the modernization of plants and plant equipment: sales methods and prices, organization and personnel, cost control, patterns, rigging, production equipment and methods, wage incentives, plant layout, materials handling, good housekeeping, and mechanized or motorized facilities.

James Thomson, Continental Foundry & Machine Co., presided at the session. E. W. Beach, Campbell, Wyant and Cannon Foundry Co., was co-chairman.

PATTERNMAKING

One technical session and a Round Table Luncheon made up the program for the Pattern Division at the 52nd Annual Foundry Congress. More than 250 foundrymen attended the technical session, held on the afternoon of May 4 to hear H. J. Jacobson, Industrial Pattern Works, speak on *"Core Box Design and Rigging for Core Blowing"* and to hear H. A. Erbe's paper on *"Metallizing Wood Patterns"* presented by L. F. Tucker of City Pattern & Foundry Co., Inc., co-chairman of the session.

In the discussion following Mr. Erbe's paper, it was brought out that it is impossible to metallize satisfactorily unless the pattern is free of shellac and other materials which prevent adherence of the metal casting.

An alternative suggestion to Mr. Erbe's process, brought out during the discussion, was to remove 1/16 in. from the pattern and replace it with sheet copper. This method, it was stated, is especially effective with large sand slingers and other mechanized molding operations. A. F. Pfeiffer, Allis-Chalmers Mfg., presided at the session.

Urges Cooperation With Foundries

Addressing the Pattern Round Table Luncheon on *"Patternmaking,"* Martin Rintz, Continental Foundry Co., hailed the trend toward more cooperation between patternmakers and foundrymen but added that there is still room for improvement.

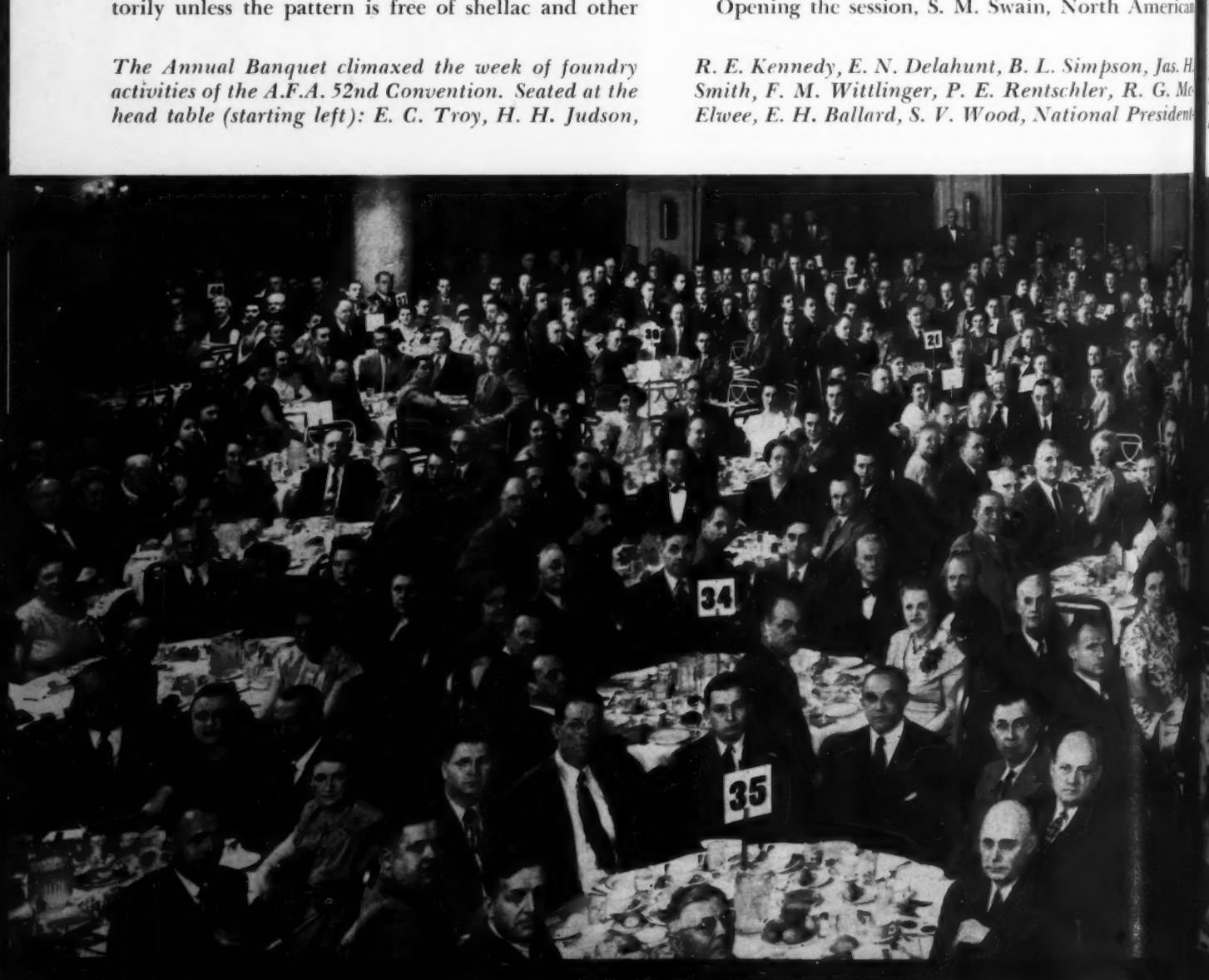
Mr. Rintz stated that patternmakers should find out from the foundry just what equipment is available and how the casting is to be made before planning and bidding on patterns. He also mentioned the use of plastic patterns, stating that they are not a cure-all, but should be used only where applicable.

REFRACTORIES

The program of the Refractories Committee consisted of two technical sessions, both held on Wednesday, May 5. At the first of the two sessions, held at Convention Hall and presided over by R. H. Stone, Vesuvius Crucible Co., with A. S. Klopf, Western Foundry Co., as co-chairman, more than 150 foundrymen and visitors attended.

Opening the session, S. M. Swain, North American

The Annual Banquet climaxed the week of foundry activities of the A.F.A. 52nd Convention. Seated at the head table (starting left): E. C. Troy, H. H. Judson, R. E. Kennedy, E. N. Delahunt, B. L. Simpson, Jas. H. Smith, F. M. Wittlinger, P. E. Rentschler, R. G. McElwee, E. H. Ballard, S. V. Wood, National President



Refractories Co., spoke on *"Testing Refractories for the Foundry."* Mr. Swain discussed tests for refractoriness, reheat change, strength, load bearing ability, spalling, porosity, water absorption, specific gravity, bulk density, chemical analysis, size, thermal conductivity and slagging of fire brick. In addition, Mr. Swain made three detailed recommendations for general types of testing programs for both small and large foundries. Following Mr. Swain's address, W. H. Owen of the Harbison-Walker Refractories Co. presented a *"Review of Refractories Used in Steel and Iron Foundries."*

"Information Please" Program

At the evening Refractories Session, held at the Bellevue-Stratford hotel and attended by some 60 foundrymen, A. S. Klopf acted as discussion leader for an "Information Please" program. Members of the speakers' panel at the session included: Robert Zoller, Zoller Steel Foundry; C. E. Bales, Ironton Fire Brick Co.; R. A. Witschey, A. P. Green Fire Brick Co.; R. P. Schauss, Illinois Clay Products Co.; R. H. Stone, Vesuvius Crucible Co.; and W. H. Owen, Harbison-Walker Refractories Co.

JOB EVALUATION AND TIMESTUDY

Speaking at the first of two technical sessions scheduled by the Job Evaluation and Timestudy Committee Dean Van Order, Burnside Steel Foundry Co., addressed an audience of 75 on *"Grinding Standards Help to Eliminate Cleaning Room Bottlenecks."*

Mr. Van Order stated that the value of a good incentive plan on stationary or swing grinding can be readily recognized by cost-minded supervisors as a means to speed up cleaning room operations.

Present grinding operations can be improved, he said, by checking sequence in which castings flow through the cleaning room, by improving pattern match between cope and drag, by improving core boxes and core prints, by eliminating excessive use of nails and vents, and by changing locations of heads and gates to make them more accessible to grinding wheels. Other factors cited by Mr. Van Order were: use of the proper grade of wheel for the average type of castings ground; use of pressure bars on stationary grinding; improved methods of holding castings rigid for swing grinding; proper burning of castings; and instruction of operators in best grinding techniques.

R. J. Fisher, The Falk Corp., presided, with M. E. Annich, American Brake Shoe Co., serving as co-chairman. Messrs. Fisher and Annich again presided at the Question and Answer Panel, held the same afternoon and attended by 60.

Speakers on the Panel were: E. G. Tetzlaff, Pelton Steel Casting Co.; M. T. Sell, Sterling Foundry; H. Reitinger, Sr., Emerson Engineers; J. A. Westover, Westover Engineers; Mr. Van Order; Mr. Fisher and Mr. Annich.

Detailed reports on the Gray Iron, Aluminum and Magnesium, Brass and Bronze, Heat Transfer, and Foundry Costs sessions will appear in the June issue of AMERICAN FOUNDRYMAN.

Elect W. B. Wallis, Dr. Karl Taylor Compton, guest speaker; National President Max Kuniansky, J. G. Pearce (British Cast Iron Research Association), James L. Wick, Jr., Fred J. Walls, Walter L. Seelbach, H. A. Deane, Wm. W. Maloney, S. C. Wasson, E. W. Horlebein, J. M. Robb, Jr., C. E. Hoyt, and W. J. MacNeill.

Convention Caricatures

Caricatures of A. F. A. members and visitors at the 52nd Annual Convention of the Association in Philadelphia, May 3-7, were made during technical meetings, receptions, dinner meetings, and at the A. F. A. Headquarters Booth. The subjects did not pose and in most cases were not aware that they were being sketched.

Some of the men were followed for several hours in order to catch them in informal unposed attitudes. The artist attempted to catch the spirit of an A. F. A. Congress, highlighted by free and cooperative exchange of ideas and information, by drawing some of the men he saw, as he saw them, without regard for official position or company affiliation.

N. S. COVACEVICH
La Consolidada, S.A.
Mexico City, Mexico

W. J. GALLANA
Rogers Brown Lavino
Philadelphia

M. M. ST. JOHN
Crane Co.
Chicago

WALTON L. WOODY
National Malleable & Steel
Castings Co.
Cleveland

ROBERT RONCERAY
Ph. Bonvillain & E. Ronceray
Seine, France

A. M. FULTON
Northern Malleable Iron
St. Paul

D. BASCH
Almin Ltd. of Great Britain
Schenectady, N.Y.

E. C. TROY
National Engineering Co.
Philadelphia

W. B. WALLIS
Pittsburgh Lectromelt Furnace Co.
Pittsburgh

H. [illegible]
Ithaca, N.Y.

M. E. BROOKS
Dow Chemical Co.
Bay City, Mich.

FITZ COGHLIN, JR.
Albion Malleable Iron Co.
Albion, Mich.

CARL F. JOSEPH
General Motors Corp.
Saginaw, Mich.

H. L. SMITH
American Smelting & Refining Co.
Pittsburgh

MAX KUNIANSKY
Lynchburg Foundry Co.
Lynchburg, Va.

E. N. DELAHUNT
Warden King, Ltd.
Montreal, Canada

B. A. MILLER
Baldwin Locomotive Works
Eddystone, Pa.

E. V. BLACKMUN
Aluminum Co. of America
Cleveland

A. O. ULLOA
Talleres Universales, S.A.
Monterey, Mexico

A. I. KRYNITSKY
National Bureau of Standards
Washington, D.C.

C. A. SANDERS
American Colloid Co.
Chicago

NEIL KENNEDY
William Kennedy & Sons, Ltd.
Owen Sound, Canada

J. H. LANSING
Malleable Founders' Society
Cleveland

D. F. SAWTELLE
Malleable Iron Fittings Co.
Branford, Conn.

JOSEPH SULLY
Neptune Meters Ltd.
Long Branch, Canada

JOHN B. ANGEL
United Nail & Foundry Co., Ltd.
St. Johns, Newfoundland

H. W. Dietert Co.
Detroit
H. W. DIETERT

E. LONGDEN
P. R. Jackson & Co., Ltd.
Manchester, England

R. M. BRICK
University of Pennsylvania
Philadelphia

DAVID TAMOR
American Chain & Cable Co.
York, Pa.

PRESIDENT ELECT

W. B. Wallis
President
Pittsburgh Lectromelt
Furnace Corporation
Pittsburgh, Pa.

VICE-PRESIDENT ELECT

E. W. Horlebein
President
Gibson & Kirk Co.
Baltimore, Md.

A.F.A. ELECTS 1948-49 OFFICERS AND DIRECTORS AT CONVENTION

WILLIAM B. WALLIS, Pittsburgh Lectromelt Furnace Corp., was elected President of the American Foundrymen's Association for 1948-49 at the Annual Business Meeting, May 5, during the Association's 52nd Annual Convention in Philadelphia.

Mr. Wallis, who is completing a one-year term as Vice-President of the Association, will take over the duties of President Max Kuniansky at the Annual Meeting of A.F.A.'s Board of Directors in July.

EDWIN W. HORLEBEIN, president of Gibson & Kirk Co., Baltimore, who is completing a three-year term as a National Director, was elected Vice-President of the Association.

Elected for three-year terms as National Directors of A.F.A. are THOMAS H. BENNERS, JR., managing partner, T. H. Benners & Co., Birmingham, Ala.; NORMAN J. DUNBECK, vice-president, Eastern Clay Products, Inc., Jackson, O.; ALFRED M. FULTON, vice-president, Northern Malleable Iron Co., St. Paul, Minn.; ROBERT R. GREGG, foundry manager, Reliance Regulator Co., Alhambra, Calif.; and VICTOR E. ZANG, vice-president, Unitcast Corp., Toledo, O.

MAX KUNIANSKY, retiring president of A.F.A., will serve for one year on the Board of Directors.

W. B. Wallis

WILLIAM B. WALLIS, President-Elect, served on several A.F.A. national technical committees and as a National Director from 1943 to 1946, prior to his election as National Vice-President in 1947.

Affiliated with the foundry industry for more than 36 years, Mr. Wallis is a native of Pittsburgh and a graduate of Pennsylvania State College. After receiving his B.S. in electrical engineering in 1911, he was for a time associated with the Cheat River hydroelectric development of the West Penn Power Co., Pittsburgh. Later, he was with the Great Shoshone and Twin Falls Power Co., Twin Falls, Idaho. In 1915, he entered the consulting engineering field with W. E. Moore & Co., Pittsburgh, and remained there until 1919, when he was appointed assistant general manager of the Jessop Steel Co., Washington, Pa. In 1920, Mr. Wallis joined Pittsburgh Lectromelt as president.

Mr. Wallis holds membership in the American Institute of Mining and Metallurgical Engineers, the American Iron & Steel Institute, the American Society for Metals, the American Society for Testing Materials, the Electro-Chemical Society and the Canadian Institute of Mining and Metallurgy.

E. W. Horlebein

EDWIN W. HORLEBEIN, Vice-President-Elect, has served on the Association's Board of Directors since 1945. He was the first chairman of A.F.A.'s Chesapeake Chapter, established in 1940. He has also served on the Executive Committee of the Association's Brass and Bronze Division.

A native of Baltimore, Mr. Horlebein has been president of Gibson & Kirk since 1924, and was previously associated with the Dixie Manufacturing Co., Baltimore, as an engineer. Mr. Horlebein began as an apprentice machinist with the Baltimore & Ohio railroad.

T. H. Benners, Jr.

Director-Elect THOMAS H. BENNERS, JR., is the immediate past chairman of the Birmingham District chapter. A charter member of the local group, he served as its vice-chairman and program director in 1945-46.

Mr. Benners is a graduate of Virginia Military Institute, where he received a degree of bachelor of science in chemical engineering in 1920. He has spent his entire industrial career with the Benners Co.

N. J. Dunbeck

NORMAN J. DUNBECK, elected to a three-year Directorship, has served on many A.F.A. sand committees and has written for the technical press on sand technology. He has presented papers on the subject at most of A.F.A.'s 39 chapters and at regional and national

conventions. He is immediate past chairman of the Central Ohio Chapter.

Born in Lancaster, N.Y., Mr. Dunbeck received a bachelor of science degree in chemical engineering from the Catholic University of America, Washington, D.C. During high school and college, he acquired a background by working summers in foundries.

Mr. Dunbeck joined Eastern Clay Products, Inc., then located in Eifort, O., in 1926, and established the company's first laboratory. He was appointed Eastern plant manager in 1927, production manager in 1931 and vice-president in 1936. He is a member of the American Ceramics Society.

Alfred M. Fulton

ALFRED M. FULTON, Director-Elect, is immediate past chairman of A.F.A.'s Malleable Division, and has served as chairman of the Twin City Chapter. For many years he has taken part in the work of several national technical committees.

Born in Chester County, Pa., Mr. Fulton entered the foundry industry with the Wilmington Malleable Iron Co., Wilmington, Del., and was later affiliated with the Baldwin Locomotive Works, Philadelphia, and with the Fort Pitt Malleable Iron Co., Pittsburgh. He joined Northern Malleable Iron Co., St. Paul, of which he is now vice-president, in 1920.

Robert R. Gregg

ROBERT R. GREGG, elected to a three-year term as a National Director, has served in that capacity since July, 1947, when he was named by the Board of Directors to complete the unexpired term of George K. Dreher of Cleveland who withdrew to become executive director, Foundry Education Foundation.

One of the organizers and first president of A.F.A.'s Southern California chapter, Mr. Gregg has been a member of the Association since 1919. He has been active in recruiting and training apprentices for the foundry industry.

Mr. Gregg joined Reliance Regulator Co. in 1927 as foundry superintendent and has been foundry manager since 1940. A native of the Isle of Man, Mr. Gregg came to the United States in 1907. He was foundry foreman with Steiger and Kerr Occidental Foundry, San Francisco in 1914, and later, successively, foundry foreman for the Hesse-Martin Iron Works, Portland, Ore.; foundry superintendent, Keystone Iron and Steel Co., Los Angeles; and consultant and apprentice instructor with the Industrial Association of San Francisco, prior to joining Reliance Regulator.

Victor E. Zang

VICTOR E. ZANG, National Director-Elect, is a charter member of A.F.A.'s Toledo Chapter, of which he was the first chairman.

Born in Toledo, Mr. Zang graduated from the University of Toledo, joining the Industrial Steel Casting Co., predecessor of Unitcast Corp., as a chemist in 1922. He was appointed works manager in 1937 and vice-president of research and development in 1947.

He is a member of the American Society for Metals and past chairman of its Toledo group, and is a mem-

(Continued on page 62)

A. M. Fulton

R. R. Gregg

T. H. Benners, Jr.

N. J. Dunbeck

V. E. Zang

Max Kuniansky

F. C. Riecks

Thomas D. Craven
1st, Non-ferrous Molding

Adolph Scanzoni
1st, Steel Molding

John Dean Morehead
1st, Gray Iron Molding

Dwight L. French
1st, Patternmaking

AFA TWENTY-FIFTH ANNUAL APPRENTICE CONTEST

TWELVE INDENTURED APPRENTICES of the foundry field earned industry-wide recognition of their skills as winners in the 25th Annual A.F.A. Apprentice Contest. They were selected April 3, when judges met in Philadelphia to conclude the 1948 contest started November 10, 1947.

Thomas D. Craven, Howard Foundry Co., Chicago, Adolph Scanzoni, Continental Foundry & Machine Co., East Chicago, Ind., and John Dean Morehead, Caterpillar Tractor Co., Peoria, Ill., placed first in non-ferrous, steel, and gray iron molding, respectively; Dwight L. French of Caterpillar Tractor Co., was awarded first place in patternmaking. These apprentices were guests of the Association during the 52nd Annual Convention and received $100 prizes and certificates at the Annual Business Meeting. Presentation was made by National President Max Kuniansky. Other prize winners received $50 and $25 for second and third place, respectively, and certificates of recognition. These usually are presented at an appropriate plant or A.F.A. chapter ceremony.

Placing second in non-ferrous molding was Frank Posanski of Allis-Chalmers Mfg. Co., Milwaukee, with Joseph J. Wienclawski, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., John Coreno, Hill Acme Foundry, Cleveland, and James J. Kennedy, Jr., Burns & Wohlgemuth, Philadelphia, receiving second prize in steel, gray iron, and patternmaking, respectively.

Third in the four contest divisions were: non-ferrous, John Wegner, Waukesha Foundry Co., Waukesha, Wis.; steel, Frank Alabaise, West Steel Casting Co., Cleveland; gray iron, John Valichnac, Fulton Foundry & Machine Co., Cleveland; and patternmaking, Robert J. Schneider, Midwest Pattern Co., Minneapolis, Minn.

All castings and patterns entered in the national contest, representing the best selected in chapter and plant contests throughout the United States and Canada, were on display during the Convention. The 12 prize-winning entries will become part of the A.F.A.-sponsored foundry exhibit at the Museum of Science and Industry, Chicago, replacing the top 1947 entries which have been on displaying during the past year.

The contest this year involved a considerably larger number of entries than in 1947, both in the national

Pattern and molding judges for the 25th A.F.A. Annual Apprentice Contest examining patterns at Philadelphia.

Casting judges E. A. Zeeb, Dodge Steel Co., (starting left), Edward Saks, Murrell Dobbins Vocational School, C. L. Lane, Florence Pipe Foundry & Machine Co., Committee Chairman Roy W. Schroeder, University of Illinois, and Professor C. W. Morisette, Pennsylvania State College, examining radiographs.

contest and in the local contests. In the Detroit Chapter contest, for example, 51 patternmaker apprentices were entered. Three innovations featured the contest this year: (1) plastic patterns and coreboxes were used for the first time; (2) a magnesium casting placed first in the non-ferrous molding division; and (3) one of the entries was accompanied by radiographs which provided proof of internal soundness.

The plastic patterns and coreboxes were used in non-ferrous molding only and were supplied through the courtesy of Ladd Salach, president, Plastic Corporation of Chicago. E. W. Pierie, plant superintendent, Motor Patterns Co., Cleveland, arranged for the steel molding patterns. Gray iron molding patterns were provided by F. W. Burgdorfer, president, Missouri Pattern Works, St. Louis. Arrangements for pattern division blueprints were made by G. J. Gedeon, head, pattern department, Aluminum Co. of America, Cleveland. Instruments for checking patterns were loaned by Fletcher Works, Inc., and plastic templates by H. J. Jacobson, Industrial Pattern Works, Chicago.

Although the non-ferrous molding division of the A.F.A. Annual Apprentice Contest has always been open to magnesium entries, as well as aluminum and the heavy non-ferrous alloys, few have been received and none was awarded first place until this year.

Arrangements for judging the 1948 contest were made by A. C. Gocher, foundry superintendent, Fletcher Works, Inc., Philadelphia, who is a member of the A.F.A. Apprentice Contest Committee. Patterns were judged at Fletcher Works while castings were judged at Dodge Steel Co., where castings were under the care of Assistant Foundry Foreman E. A. Zeeb.

Seven Philadelphia area judges selected the winning castings and patterns. Casting judges were: C. L. Lane, metallurgist, Florence Pipe Foundry & Machine Co., Florence, N.J., who is vice-chairman of the Philadelphia chapter; Professor C. W. Morisette of the industrial engineering department of Pennsylvania State College, and vice-chairman of the A.F.A. Apprentice Contest Committee; Edward Saks, instructor, Murrell Dobbins Vocational School, Philadelphia; and Mr. Zeeb.

Patterns were judged by: Joseph R. Hagar, Sr., assistant superintendent of foundries and pattern shop,

Frank Alabaise
3rd, Steel Molding

Frank Posanski
2nd, Non-ferrous Moldin

John Wegner
3rd, Non-ferrous Molding

James J. Kennedy, Jr.
2nd, Patternmaking

John Valichnac
3rd, Gray Iron Molding

John Coreno
2nd, Gray Iron Molding

Robert J. Schneider
3rd, Patternmaking

Left to right, Henry L. Rosse, Eddystone Borough Schools, J. E. Foster, A.F.A. headquarters technical staff, Joseph R. Hagar, Sr., Baldwin Locomotive Works, and Charles W. Mooney, Jr., Olney Foundry Division, Link-Belt Co., all pattern judges except Mr. Foster.

Baldwin Locomotive Works, Eddystone; Charles W. Mooney, Jr., superintendent of the Olney Foundry Division, Link-Belt Co., Philadelphia; and Henry L. Rosse, coordinator of vocational education, Eddystone Borough Schools.

Apprentice Contest Committee Chairman Roy W. Schroeder, instructor in foundry practice and patternmaking, Navy Pier Branch, University of Illinois, Chicago, and J. E. Foster of the A.F.A. headquarters technical staff, coordinated the judging and disclosed the names of the winners who were identified only by numbers until judging was completed.

Most of the 1948 winners were in service during the war. Several were in the A.F.A. Annual Apprentice Contest in previous years, and some have been associated with foundry work only since leaving the armed forces. Dwight L. French, first place winner in the patternmaking division, has been in the contest twice before. An apprentice at Caterpillar Tractor Co., Peoria, from June 1941 to December 1942 and since January 1946, he spent three years in Europe with the Army medical corps. He was born in Mt. Pleasant, Iowa, December 22, 1921, where he went to high school.

Following the trade of his father, James J. Kennedy, who was second in patternmaking, apprenticed himself to Burns & Wohlgemuth, Philadelphia, in August 1946. Evenings he attends Murrell Dobbins Vocational School. A native of Philadelphia and 21 years old, he served 27 months in the South Pacific with the Navy.

An apprentice only 10½ months, third prize winner Robert J. Schneider works at Midwest Pattern Co., Minneapolis. Born in St. Paul, Minn., July 22, 1928, he is a graduate of Mechanic Arts High School and of the patternmaking class at St. Paul Vocational School.

Molder of the best casting in the non-ferrous division, Thomas D. Craven took first place with a magnesium casting made at Howard Foundry Co., Chicago. Father of four children, he has been an apprentice molder since July 1946. He was born in Kentucky on August 24, 1924, and went to school in Louisville.

Frank Posanski, who placed second in non-ferrous molding, won first place in the Wisconsin Chapter contest this year and second place in 1947. Starting as a laborer in the Allis-Chalmers brass foundry he served in the Army air corps for over two years, including 20 months in Italy. Returning in November 1945 he became a crane operator and started a four-year apprenticeship on January 2, 1946.

Another frequent winner is John H. Wegner who received third prize in the non-ferrous division of the national contest. He placed third in the Wisconsin Chapter contest this year, and in 1947 was first in nickel alloy molding and third in stainless steel. In service 18 months, he has been an apprentice at Waukesha Foundry Co., since November 1945.

John Dean Morehead, Caterpillar Tractor Co. apprentice who placed first in gray iron molding, spent almost five years as a nose gunner in a B-24 bomber in the European theater. Born in Carlinville, Ill., he went to school there, joining Caterpillar in the fall of 1945.

Second prize winner in the gray iron molding division, John A Coreno, was born in Cleveland, May 30, 1925. Before spending 2½ years on a battleship he was a foundry laborer at the Hill Acme Co., Cleveland, where he has been an apprentice since January 1947.

John Valichnac, third prize winner in gray iron, has been an apprentice of Fulton Foundry & Machine Co., Cleveland, less than two years. Prior to serving 33 months in the Army in Europe he was a tool grinder and attended Cleveland Trade School.

Planning on a foundry career, Adolph Scanzoni, best steel molder in the 1948 contest, has spent almost two years as an apprentice of Continental Foundry & Machine Co., East Chicago, Ind. In the Army from 1942 to 1945, he served two years as staff sergeant with an anti-aircraft battalion in Europe where he earned four battle stars.

Frank Alabaise, awarded third prize in steel molding, is a local contest veteran, having won first in 1948 and third in 1947 in the Northeastern Ohio Chapter contest. A molding apprentice for almost three years at West Steel Casting Co., Cleveland, he started work in the core room as a laborer in 1941 where his brother, Joseph, is a journeyman coremaker. From early 1943 to the fall of 1945 he was in the combat engineers and later in the 8th air corps.

A.F.A. Chapters Launch Campaign To Recruit and Train Apprentices

Simultaneous campaigns to recruit and train foundry apprentices are announced by the Wisconsin and the Southern California Chapters.

The Wisconsin Chapter campaign is based on a similar promotion sponsored in 1947 by the Northwestern Pennsylvania Chapter and features a series of five advertisements to be run in the *Milwaukee Sentinel* and the *Milwaukee Journal*. Purpose of the program is to acquaint the public with the important part the foundry industry plays in our national economy and its advantages as a place to work. In addition, a brochure, *"Your Future in the Foundry,"* which formed an integral part of the Northwestern Pennsylvania's program for recruiting high school graduates, is being reprinted with the locale of the story changed to Wisconsin.

Southern California Chapter's campaign will also feature distribution of *"Your Future in the Foundry,"* plus a folder mailed to all foundries in the area, urging enrollment of employees in the Chapter's Apprentice Training Course, which is currently being conducted at Huntington Park High School, Los Angeles.

STUDENT CHAPTERS BROADEN FOUNDRY EDUCATIONAL SCOPE

ENTHUSIASTIC ACCEPTANCE and active participation in A.F.A.'s Student Chapter Program by foundrymen, students and faculties throughout the country have been responsible for its rapid growth. Today, slightly more than a year after the inception of the program, there are five student chapters located in top engineering schools and colleges, with three more chapters expected to be installed this fall.

A student chapter, formed at the University of Minnesota in 1941, proved to be of such value to both the students and the foundry industry as a whole that the A.F.A. National Board of Directors last year authorized a nationwide program, inviting accredited engineering schools to form chapters.

Student groups at Missouri School of Mines and Metallurgy, Ohio State University, and Massachusetts Institute of Technology petitioned for recognition and were installed. The Oregon State College group has had its petition accepted and will be installed in the fall. It is anticipated that chapters will be formed at the University of Wisconsin, Cornell University, and the University of Michigan during the fall school term.

Program Promotes Industry-College Cooperation

The Student Chapter Program was formulated by the A.F.A. in recognition of the need for close cooperation between engineering colleges and the foundry industry to insure adequate training of "new blood."

The advantages of the program to both the student and to the foundry industry are manifold. First, membership in the A.F.A. offers the student contacts in an industry providing unlimited opportunities for college graduates. Working closely with A.F.A. Headquarters and the local chapters, members of the student group are given the opportunity to mingle with key men in all phases of the foundry industry.

Second, the A.F.A. offers assistance to the student engineer in placing him in summer jobs that will give him the practical experience necessary to the furtherance of his career. Upon graduation, a wide choice of foundry and metallurgical positions is made available to the young engineer through the efforts of A.F.A.

Members of the Student Chapter at the Missouri School of Mines and Metallurgy at work in the shops and laboratories of the foundry department. Reading from top to bottom (1) Operating a high frequency induction melting furnace (2) Positioning casting for radiographic examination (3) Operating a crane, part of the School's mechanical foundry equipment (4) A corner of the metallographic laboratory at M.S.M. (5) A student member tests green sand for permeability.

Left, student members of the University of Minnesota Chapter making sand tests in the University's foundry control laboratory. Below, tapping a heat from a 15-inch cupola in the foundry laboratory. Combustion control equipment at right adjusts blast volume to maintain predetermined gas analysis in stack.

Third, the student member enjoys the same advantages and status in A.F.A. as its regular members and, as such, is entitled to receive the Association's technical assistance, its publications at a discount, and miscellaneous literature free of charge.

Must Petition A.F.A. Board of Directors

Each student chapter is formed by submitting a petition signed by 15 or more students, subject to approval of A.F.A.'s Board of Directors. The chapter appoints its own officers from the student members, a Faculty Advisor and an Industrial Advisor.

The Industrial Advisor, generally a prominent local foundryman and a member of the nearest A.F.A. chapter acts as contact man between the students and the foundry industry. He also works with the program chairman of the student group. It is a general practice for the local chapter to invite members of the student group to participate in its meetings, and the chapter chairman of the student group is invited to attend A.F.A.'s annual Chapter Chairman Conference on the same basis as regular chapter chairmen.

Formed Minnesota Student Chapter in 1941

A. F. A.'s first student chapter was formed, on a more or less experimental basis, at the University of Minnesota in 1941 by students under H. F. Scobie, now acting editor, AMERICAN FOUNDRYMAN, who became industrial advisor along with Fulton Holtby, also of the school's foundry department. During the war, a shortage of members forced the student chapter to deactivate.

J. H. Anderson **Carter DeLaittre**

When the National Board of Directors approved the Student Chapter Program in January, 1947, the first to petition was the University of Minnesota group, with James H. Anderson, instructor in the mechanical engineering department, charter member and secretary of the first student chapter, as Faculty Advisor, and Carter DeLaittre, Minneapolis Electric Steel Casting Co., as Industrial Advisor. John Hermanson was elected chairman of the student chapter, with Lyde M. Irwin as vice-president; Harry Sauby, secretary, and Ted Swanson, treasurer.

Work Closely With Twin City Chapter

The Twin City Chapter and the Student Chapter are working together closely to promote interest in the foundry industry at the University. The chairman of the student group is serving on the Educational committee of the Twin City Chapter, which is working out a plan to offer a fellowship to an undergraduate at the University. The Committee also plans to revive the annual prize contest for the best student papers presented before the Twin City Chapter on some phase of foundry practice.

At present, the Student Chapter holds two meetings each month. One meeting consists of a field trip to a nearby foundry, and the other is an evening session featuring a speaker from the Twin City Chapter.

Foundry practice at the University of Minnesota has advanced since 1941 but the courses and equipment are basically the same as those described in a paper by F. Holtby and H. F. Scobie entitled *"A University Course in Foundry Control Methods,"* A.F.A. TRANSACTIONS, vol. 49, p. 310 (1941).

The University's mechanical engineering department and members of the Twin City and Student

Chapters are currently cooperating in the selection of equipment for the modern foundry and laboratory to be located in the basement of the school's new engineering building.

Missouri Mines Forms Second Chapter

First to follow the University of Minnesota's lead in petitioning for a charter was the Missouri School of Mines and Metallurgy, which has long featured a comprehensive foundry course in its curriculum.

J. E. Reynolds, Jr., was elected chairman of the student chapter; Gordon Moline, vice-chairman; John G. Reilly, secretary; and Stanley Zirinski, treasurer. Dr. D. S. Eppelsheimer, in charge of the school's metal castings program, is Faculty Advisor and George E. Mellow, Liberty Foundry Co., of the St. Louis Chapter, Industrial Advisor.

Cooperation with the St. Louis Chapter enables the students to make frequent inspection trips through various foundries of the district. Senior trips give students the opportunity to tour some of the Midwest's largest foundries. The importance of literature in both practical and theoretical aspects, made available through A.F.A., is stressed. Students are counseled on making extensive researches into the literature dealing with their special problems.

Courses offered at the Missouri School of Mines and Metallurgy are comprehensive, beginning with general metallurgy courses, followed by iron and steel, physical metallurgical testing, alloys and metallography, nonferrous, special problems, radiography, refractories, metallurgical calculations and many others.

Make Special Foundry Investigations

Special investigations include studies of foundry layout and design, gating and risering, sand control, effect of alloying elements on castings, inoculants and various other subjects pertaining to all phases of the foundry industry.

J. H. Tressler

D. C. Williams

Student members of A.F.A. are currently taking special problem courses and aiding in the design and construction of a complete, modern gray iron foundry. A cupola with a 30-in. shell will be lined down to 15 in. for operation.

The Missouri School of Mines and Metallurgy Student Chapter plans to bring well-known technical speakers to the campus and has outlined several projects to be announced later.

Install Student Chapter at MIT

The Massachusetts Institute of Technology Student Chapter was installed on March 2 of this year by A.F.A. National President Max Kuniansky and National Secretary-Treasurer Wm. W. Maloney.

Past National Director Rufus F. Harrington, Hunt-Spiller Mfg. Corp., A.F.A. Penton Gold Medalist and a member of the New England Foundrymen's Association, was appointed Industrial Advisor to the student chapter, and Howard Taylor, A.F.A. Simpson Gold Medalist and associate professor, department of metallurgy, Faculty Advisor.

Ohio State University foundry students making small floor molds.

V. E. Zang

E. H. Taylor

Gerald J. Grott was elected chairman of the student chapter, Leonard W. McKibben, vice-chairman; Martin J. O'Brien, III, secretary-treasurer; and L. M. Diran, technical secretary.

A.F.A. student members at MIT receive a broad foundation in general education and in the scientific and technical fundamentals of the professional engineering fields. There is no "foundry course" as such, however, four-year curricula in metallurgy, mechanical engineering, and in business and engineering administration permits the inclusion of foundry work.

Offer Upperclassmen Many Courses

The student's first and second year work is largely confined to basic engineering subjects and he is not committed to a definite foundry training program until his third year. Scholarship students are expected to spend the summers following their third year working in a foundry at prevailing wages, and to take such specialized subjects as engineering metals, metal processing, iron and steel foundry engineering, industrial physical metallurgy, special problems and a thesis on some subject in the foundry field. This may consist of a study of a problem in metallurgy or engineering, research in cost accounting, time study or plant layout.

Several courses in ferrous and non-ferrous processes, physical metallurgy, metallography, X-ray, welding, and ceramics are available as elective subjects.

Student members, cooperating with the A.F.A. and NEFA are given an opportunity to visit foundries in the area and to do cooperative thesis and special problem work with them. Arrangements have also been made for student members to do cooperative work with the Boston Navy Yard and the Watertown Arsenal.

Ohio State University, where for more than 50 years a course in foundry practice has been taught, has 25 student A.F.A. members. A large percentage of the speakers at the Student Chapter meetings are Ohio State University graduates active in the foundry industry. As a general rule, guest speakers for the Central Ohio Chapter meetings visit the campus prior to speaking at the regular chapter meetings.

The Central Ohio Chapter has cooperated with the student group in many ways, including the donation of equipment to provide the school's laboratory with a mechanized foundry, and financial assistance to the Student Chapter. In addition, the American Foundrymen's Association has donated a 500 lb direct-arc melting furnace to the school.

At present, Ohio State's foundry department is un-

National officers of A.F.A., officials of the New England Foundrymen's Association, faculty members and student chapter officers at the installation ceremonies of the Massachusetts Institute of Technology, March 2, are, seated left to right: Wm. W. Maloney, A.F.A. National Secretary-Treasurer; Prof. John Chipman, head of MIT's Department of Metallurgy; Max Kuniansky, A.F.A. National President; Gerald J. Grott, student chapter chairman; and R. F. Harrington, Hunt-Spiller Corp., Industrial Advisor to the student chapter. Standing, left to right, Merton Hosmer, Hunt-Spiller Corp.; Prof. Howard F. Taylor, Faculty Advisor; Prof. Erwin H. Schell, head of MIT'S Business and Engineering Administration department; Prof. Nicholas J. Grant; Martin J. O'Brien, secretary treasurer of the student chapter; Walter Clark, D. W. Clark Co.; and Leonard McKibben, student chapter vice chairman.

MIT student chapter members cook "hot dogs" with foundry equipment at the chapter's installation night.

dergoing a transitional period as the result of a revamping of the curriculum in July of last year by Dr. Douglas C. Williams, assistant professor in the Department of Industrial Engineering, and a Faculty Advisor to the Student Chapter. Seven new courses in foundry technology will shortly be presented the University's faculty for its approval.

In addition to Dr. Williams, the Ohio State Student Chapter has a second Faculty Advisor, R. P. Schneider, for more than 25 years a teacher of foundry practice in the Ohio-Pennsylvania area.

Five Industrial Advisors Aid OSU Group

The Ohio State Student Chapter is exceptionally fortunate in that five chapters throughout the state take an active interest in its welfare, as do many of the Ohio foundries, which have contributed equipment and financial assistance to the foundry department.

The student chapter has five Industrial Advisors, among them, A.F.A. National Director Elect Victor E. Zang, Unitcast Corp., representing the Toledo Chapter; J. Schumacher, Hill & Griffith Co., Cincinnati Chapter; J. J. Witenhafer, Columbus Malleable Iron Co., Central Ohio Chapter; E. H. Taylor, F. E. Myers & Brother Co., Canton Chapter; and J. H. Tressler, Hickman, Williams & Co., Northeastern Ohio Chapter.

William Dundon is *chairman* of the Ohio State Student Chapter; Thomas S. Dole, vice chairman; and Eldon Boner, secretary-treasurer.

Form Chapter at Oregon State College

A petition by students of Oregon State College to form A.F.A.'s first West Coast student chapter was recently approved but the chapter will not be officially installed until this fall. H. R. Dahlberg, assistant professor in the school's industrial arts department, and former chairman of the University of Minnesota Student Chapter, is Faculty Advisor, with W. B. Kirby, Electric Steel Foundry Co., Portland, Industrial Advisor to the Chapter.

Ted Sullivan has been elected chairman of the student chapter; John Oettinger, vice-chairman; John Meece, secretary; and Everett Uebel, treasurer.

The spirit of cooperation between the foundry industry, students and schools has been responsible for the growth of the A.F.A. Student Chapter Program—a program that will insure greater appreciation of cast metals and the casting processes, and that will provide a continuous supply of technically-trained foundrymen.

H. R. Dahlberg

J. S. Schumacher

D. S. Eppelsheimer

R. P. Schneider

Missouri School of Mines Student Chapter Installed

An impressive banquet, attended by prominent St. Louis foundrymen, faculty members and undergraduates of the Missouri School of Mines and Metallurgy, marked the official installation of the School's Student Chapter, March 24.

James E. Reynolds, student chapter chairman, opened the installation ceremonies by introducing N. L. Peukert, Carondelet Foundry Co., chairman, St. Louis chapter, A.F.A., who expressed the desire of his group to cooperate in every way possible with the newly-formed student chapter.

Mr. Reynolds then presented the senior officers and members of the St. Louis chapter; Paul Retzlaff, Busch Sulzer Bros. Diesel Engine Co.; J. E. Williamson, General Metals Corp.; George Mellow, Liberty Foundry Co.; Henry W. Meyer, General Steel Castings Co.; and W. A. Zeis, W. A. Zeis Foundry and Equipment Co.

Many members of the school's faculty, including Dean C. L. Wilson, Assistant Dean R. Z. Williams, Dr. A. W. Schlechten, Dr. H. R. Hanley, Dr. D. S. Eppelsheimer, Prof. D. F. Walsh, Dr. P. G. Herold, Dr. O. W. Grawe, Dr. Z. V. Harvalik, Noel Hubbard and E. J. Randolph, attended the installation banquet as an expression of their interest in the student group.

Dean Wilson welcomed the installation of the Student chapter on behalf of the faculty of the Missouri School of Mines and Metallurgy, forecasting a profitable association between the School and A.F.A.

Dean Wilson then introduced the principal speaker of the evening, National Secretary-Treasurer Wm. W. Maloney, who spoke on *"What Is the American Foundrymen's Association and What Does It Represent?"* Mr. Maloney stressed the need for college graduates in the metal castings industry and stated that the foundry industry must cooperate in training prospective foundrymen by posting college faculties on its educational needs.

Mr. Maloney then welcomed the new student chapter into the A.F.A. by presenting the traditional cast iron rattle to Chapter Chairman Reynolds, who pledged the chapter to the advancement of knowledge of the castings industry.

Mr. Reynolds then introduced other student chapter officers: Gordon H. Moline, vice chairman; John G. Reilly, Jr., secretary; Edwin E. Cornelius, program chairman; John W. Mitchell, publicity chairman; and Stanley Zirinski, treasurer.

The chapter faculty advisor, Dr. Eppelsheimer, expressed his satisfaction with the way in which the student group solved problems in the installation of the School's newly-acquired cupola.

The step-by-step procedures necessary to the making of a casting and its cost estimation were described by George Mellow, the chapter's industrial advisor.

Other student members attending were: Edward Brundidge, John H. Cox, Richard Frazier, Lawrence C. Glasgow, William Harris, C. Isbel, Elias Kapernaros, Edward C. Littell, William Parkinson and Martin I. Slawsky.

Re-Name Two A.F.A. Representatives As Educational Foundation Trustees

Two members of A.F.A., National Director Stowell E. Wasson, manager, National Malleable & Steel Casting Co., Cicero, Ill., and Educational Division Chairman F. G. Sefing, research metallurgist, International Nickel Co., New York, were recently reappointed to the Board of Trustees of the Foundry Educational Foundation.

Mr. Wasson and Mr. Sefing have been trustees of the Foundation since its organization early last year, under the sponsorship of the American Foundrymen's Association, the Gray Iron Founders' Society, the Malleable Founders' Society, and the Foundry Equipment Manufacturers' Association.

The purpose of the Foundation is to encourage promising young men to enter special courses of engineering training in preparation for management positions in the foundry industry. To this end, the Foundation is aiding six geographically well-distributed engineering colleges to develop and arrange foundry courses, to procure needed foundry equipment, and to establish scholarships.

James E. Reynolds, Chairman, Student Chapter, Missouri School of Mines and Metallurgy (second from left) accepts the cast iron rattle symbolizing A.F.A. membership from National Secretary Wm. W. Maloney at installation ceremonies March 24. Looking on are, left to right, George E. Mellow, industrial advisor to the chapter; Dean Wilson, Missouri School of Mines and Metallurgy; and Dr. D. S. Eppelsheimer, faculty advisor.

OREGON STATE COLLEGE

STUDENT CHAPTER APPROVED

MOST RECENT ADDITION to A.F.A.'s fast-growing Student Chapter family is Oregon State College, whose petition for membership was approved by the National Board of Directors last month.

Although the Chapter's official installation will not take place until the beginning of the new school term this fall, the student group has been authorized to operate as a full-fledged chapter.

Last February, some 30 students of Oregon State College signed a petition requesting a Student Chapter charter, at the instigation of H. R. Dahlberg, assistant professor of the industrial arts department. Mr. Dahlberg won A.F.A.'s National Student Essay Contest while an undergraduate in the Foundry department of the University of Minnesota in 1943.

The chapter has selected W. B. Kirby, engineer, Electric Steel Foundry Co., Portland, as its industrial advisor. Mr. Kirby has been prominent in the Oregon Chapter of the Association and was guest speaker at the Student Chapter's first meeting, held April 29 at the Corvallis hotel, Corvallis. Mr. Kirby spoke on *"The Need of College Men in the Foundry."* He said that even though the foundry industry is one of the oldest known to man, there are still many applications of science and engineering to be made. In some foundries, operations are more of an art than a science.

At the Oregon Chapter meeting the evening of April 16, sixteen students members of the Association were guests of C. V. Burley, Carborundum Co., Portland.

Officers of the Student Chapter, elected early in March are: chairman, Ted Sullivan; vice-chairman, John Oettinger; secretary, John Meece, and treasurer, Everett Uebel.

Members of the Oregon Chapter are cooperating with the Oregon State group by offering summer employment to the students, as a result of which the college group will be able to see and practice on an industrial basis the engineering principles learned in school.

Oregon State College students who signed the petition for a student chapter are: Jesse Myles Bell, Walter A. Wilson, Charles E. Lauderdale, Fred B. Gotter, Robert R. Peel, Adrian E. Bee, Roby E. Poffenberger, Leonard M. Preston, Everett M. Uebel, William P. Sorenson, John H. McLeon, William W. Waite, Wyman F. Mills, Edwin F. Otey, Harvey J. Head, Douglas H. Blair, Anson H. Cleveland, David E. Crabtree, Earl E. Hawks, William L. Regele, Glen S. Shepard, Ted Sullivan, Jr., James H. Skeel, Keith N. Soderlund, Gilbert V. Kamara, John P. Meece, John F. Oettinger, Dwight W. Averill, Darwin H. Wissenback and Russell A. Ward.

EDITOR'S NOTE: The editorial, *"Foundry Art Becomes Science Through Research,"* page 35, in this issue, and *"Small Foundries Can Engage in Research and Development"* by Harry Czyzewski of Metallurgical Engineers, Inc., Portland, which appeared in the March issue of AMERICAN FOUNDRYMAN, describe the ever growing search for fundamentals of foundry practice.

Members of the Oregon State College Student Chapter photographed at their first meeting, April 9.

Elect Officers and Directors

(*Continued from Page 51*)

ber of the American Institute of Mining and Metallurgical Engineers.

F. C. Riecks

FRANK C. RIECKS, manager of foundry operations for the Ford Motor Co., Dearborn, Mich., was elected to the National A.F.A. Board of Directors at a Board meeting held May 4 at the Benjamin Franklin hotel, Philadelphia. Mr. Riecks will fill the unexpired term of the late Russell Hudson McCarroll, also of the Ford Motor Co., who died March 31.

Mr. Riecks, whose directorship expires in 1950, has attained an international reputation as a foundry design and construction engineer. As manager of the world's largest foundry operation, he supervises approximately 10,000 employees.

Born April 13, 1894, at Alpena, Mich., Mr. Riecks received a degree of bachelor of science in mechanical engineering from the University of Michigan in 1916. After a brief period as a draftsman with the Timken Detroit Axle Co., he joined Ford as a power plant draftsman in the fall of 1916.

Commissioned a second lieutenant of artillery at the outbreak of World War I, he was transferred to the Air Corps as an instructor in aerial gunnery and later saw action with the American Handley-Paige Bomber Squadron, based at Manchester, England.

Returning home in 1919, Mr. Riecks was made assistant superintendent of the Eagle Boat Outfitting branch of Ford's River Rouge (Mich.) plant. In 1921, he was appointed assistant superintendent of maintenance and construction of the River Rouge plant, and, in 1922, assistant to the plant's chief accountant.

From 1924 to 1931, Mr. Rieck was engaged in the design and construction of the Rouge open hearth and steel mill plant. Upon completion of the project, he was sent to Shanghai for five months to survey possible sites for a Ford plant in China.

He returned to Dearborn as assistant chief plant engineer and in this capacity designed such projects as Ford's glass plant, forge plant and several branch plants, in addition to preparing the foundry for the advent of the V-8 cylinder block.

In 1935, Mr. Rieck was sent to Yokahama, Japan, to choose and arrange for purchase of a site for a new Ford plant. He returned to the United States for a year, and again was sent to Japan, this time to construct a new Ford plant on Tokyo bay, near Yokahama. The project was stopped shortly afterward by Japanese military officials because of the then-current war scare.

Upon Mr. Rieck's return to the United States in 1938, he was placed in charge of construction of several Ford projects, including a press plant, enlarging of open hearth furnaces, installation of foundry conveyor systems and modernization of core making operations.

Mr. Rieck spent the following year in designing and constructing the French automotive manufacturing plant at Poissy, near Paris. The plant later fell into the hands of the Germans during the invasion of France and was operated by them throughout the war.

Returning to the United States in 1939, Mr. Rieck, as assistant chief plant engineer, designed and constructed many vital war projects, including the famous Willow Run bomber plant, a tank manufacturing plant, the Pratt & Whitney aircraft engine plant, and several foundries.

Following the war, he was placed in charge of the rehabilitation of the Rouge gray iron foundries. Some $12 million has been spent on this project which has succeeded in improving working conditions 100 per cent and in increasing capacity 25 per cent.

In 1947 Mr. Rieck was appointed to his present position as manager of Ford foundry operations, consisting of the production foundry, the jobbing foundry, and the metal and wood pattern shops.

Association Officials Help Install University of Minnesota Chapter

AN INSPECTION TRIP through the University of Minnesota's foundry department and a dinner meeting attended by A.F.A. Officers and Directors, University officials and students marked the official installation of the Student Chapter at the Coffman Memorial Union on the campus, April 8.

The University of Minnesota Student Chapter was originally formed in 1941 but wartime conditions made it necessary to deactivate the chapter. Last year, when the National Board of Directors approved the Student Chapter Program, the Minnesota group was first to petition and first group to be approved.

Preceding the installation dinner, members of the Chapter and their guests inspected the facilities of the University's Foundry department, and heard Fulton Holtby, Minnesota's superintendent of industrial laboratories, speak on the University's $2,300,000 engineering building, now under construction, which will offer increased facilities for foundry and laboratory work.

The dinner meeting at the Union was opened by the group's Faculty Advisor, James Anderson, foundry instructor at the University, who gave a brief history of the original Student Chapter.

John Hermanson, Student Chapter Chairman, acting as toastmaster for the evening, introduced Dean Teeter of the University of Minnesota Institute of Technology, who welcomed the chapter for the University and cited advantages of belonging to a technical society.

Sheldon P. Pufahl, Pufahl Foundry, Inc., chairman of A.F.A.'s Twin City Chapter, pledged his Chapter's full cooperation, and stated that the Twin City Chapter is establishing a scholarship fund to help students at the University who are interested in foundry work.

A.F.A. National Secretary-Treasurer Wm. W. Maloney, spoke on the opportunities offered to students by membership in the A.F.A. and the opportunities for the college graduate in the foundry industry. Mr. Maloney then presented Chapter Chairman Hermanson with the traditional cast iron rattle symbolizing recognition as an A.F.A. chapter.

In attendance at the meeting were S. V. Wood, former National President of A.F.A. and a regent of the University of Minnesota; H. H. Judson, A.F.A. National Director; Carter DeLaittre, Minneapolis Electric Steel Castings Co., Industrial Advisor to the Student Chapter; Miss Lillian K. Polzin, secretary of the Twin City Chapter; and Prof. O. W. Potter, former foundry instructor at the University. In addition, student chairmen of other technical societies were present, including those of ASME, AIEE, ASCE, and representatives of the School of Mines and the Technical Commission.

A. F. A. STAFF CHANGES STRENGTHEN ACTIVITIES

SEVERAL CHANGES HAVE BEEN MADE RECENTLY in the National Office Staff for further development of the Association's educational activities, and for the strengthening of AMERICAN FOUNDRYMAN.

Herbert F. Scobie, in charge of educational activities since he joined the staff in October 1945, has been appointed Acting Editor of AMERICAN FOUNDRYMAN. Formerly foundry consultant and instructor in foundry practice and in chemistry at the University of Minnesota, where he graduated in 1935, he brings to the Association's magazine a knowledge of foundry operations that is expected to enhance the practical as well as the technical content of published information.

Appointment of Mr. Scobie is a natural development of the prestige that AMERICAN FOUNDRYMAN has earned for itself since it was expanded to its present form in May, 1945, following the demands of an increasing membership for a better Association publication. His knowledge of foundry techniques and his familiarity with men of the industry is another step in the direction of better editorial coverage and increased usefulness to the foundry industry.

Robert N. Sheets has joined the staff as Assistant Editor of AMERICAN FOUNDRYMAN, following the resignation on March 15 of Gerald R. Buhler. (*See Foundry Personalities, page 123*). Prior to the war, Mr. Sheets was connected with Western Newspaper Union, Chicago, as assistant editor and feature writer. From 1941 to 1945 he served with the Second Armored Division as a combat correspondent and editor of division and corps newspapers in the North Africa, Sicilian and European campaigns, during which, he received a Bronze Star for meritorious service. Since his discharge from the Army, he has served as managing editor of *Electric Light and Power magazine,* Chicago.

H. F. Scobie

R. N. Sheets

Charles R. McNeill who formerly worked on A.F.A. TRANSACTIONS and transferred to the editorial staff of AMERICAN FOUNDRYMAN in May, 1945, will continue on the magazine as Editorial Assistant.

Following appointment of H. F. Scobie to AMERICAN FOUNDRYMAN, Philip D. Johnson has joined the National Office Staff in charge of educational activities. A native of New Hampshire, his father is a retired engineering officer of the U. S. Navy and the oldest living apprentice of the Boston Navy Yard. Mr. Johnson was educated in New England schools and graduated from Northeastern University, Boston, in 1937 with a B.S. degree in mechanical engineering. Later he completed extension courses at Harvard University

C. R. McNeill P. D. Johnson

and was instructor in ESMWT courses in radiography at his alma mater during the war.

On graduation Mr. Johnson became a laboratory technician at the Boston Navy Yard, where he spent considerable time in the foundry. Between 1941 and 1946 he developed broad contacts in the foundry and other industries as a sales engineer for Radium & Radon Corp., Chicago, and the Canadian Radium & Uranium Corp. Since, he has been secretary and editor of the American Industrial Radium and X-Ray Association as well as a consulting radiographer. Prior to joining A.F.A. he was connected with Montgomery Ward & Co., Chicago, as manager of the merchandise literature section.

Because of the foundry industry's intense interest in education, as a result of the A.F.A. program of the past several years and the development of the Foundry Educational Foundation, a concentrated program of educational activities has been developed. Mr. Johnson will spend considerable time consulting with chapters, schools, and plants in development of educational programs and facilities for foundry instruction, an activity closely connected with the text books now being written under A.F.A. auspices for the college, vocational school and high school levels of education.

Sand Research Report Available

A reprint of the *"Seventh Annual Report on Investigation of Properties of Steel Sands at Elevated Temperatures"* which appears in TRANSACTIONS OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION, vol. 55, is available as a separate publication. This report covers work completed during 1946 on the Sand Research Project sponsored by the Sand Division of A.F.A. at Cornell University.

Members of the Association may receive a copy of this report without charge on request. Mail requests to S. C. Massari, Technical Director, American Foundrymen's Association, 222 W. Adams St., Chicago 6, Ill.

Use of oxygen-enriched cupola blasts has proven successful for increasing melting rates and tapping temperatures with a given coke ratio and blast volume. Melting rates have been increased as much as 40 per cent by adding approximately 14 per cent oxygen to the blast. Melting and tapping temperatures have been raised from 25 to 150 F by manipulating the oxygen addition and total blast volume.

Savings in coke with no sacrifice in operating conditions can be made by the use of oxygen enrichment. Most important of all, oxygen is useful in overcoming bridging and cold metal conditions and often can be used to save a heat from freezing in the furnace rather than resorting to dropping the bottom. Oxygen enrichment can be used as a control to regulate melting rate and tapping temperature.

CUPOLA OPERATIONS IMPROVED WITH OXYGEN-ENRICHED BLAST

W. C. Wick
Associate Metallurgist
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Chicago

FOR THE PAST FEW YEARS the steel industry in cooperation with several oxygen producing companies has been investigating the possibility of using commercial oxygen to facilitate melt down and quality control in steel making processes. These experiments apparently are showing encouraging results in the form of increased production capacity by faster melting time and more rapid chemical refining.

New and diversified applications for commercial oxygen in large volume are rapidly coming into existence. One of these new applications is in conjunction with cupola operation in the foundry industry. A number of scattered verbal reports on the use of high purity commercial oxygen as an addition to the cupola air blast have been heard, and brief mention of it has been made in trade publications.

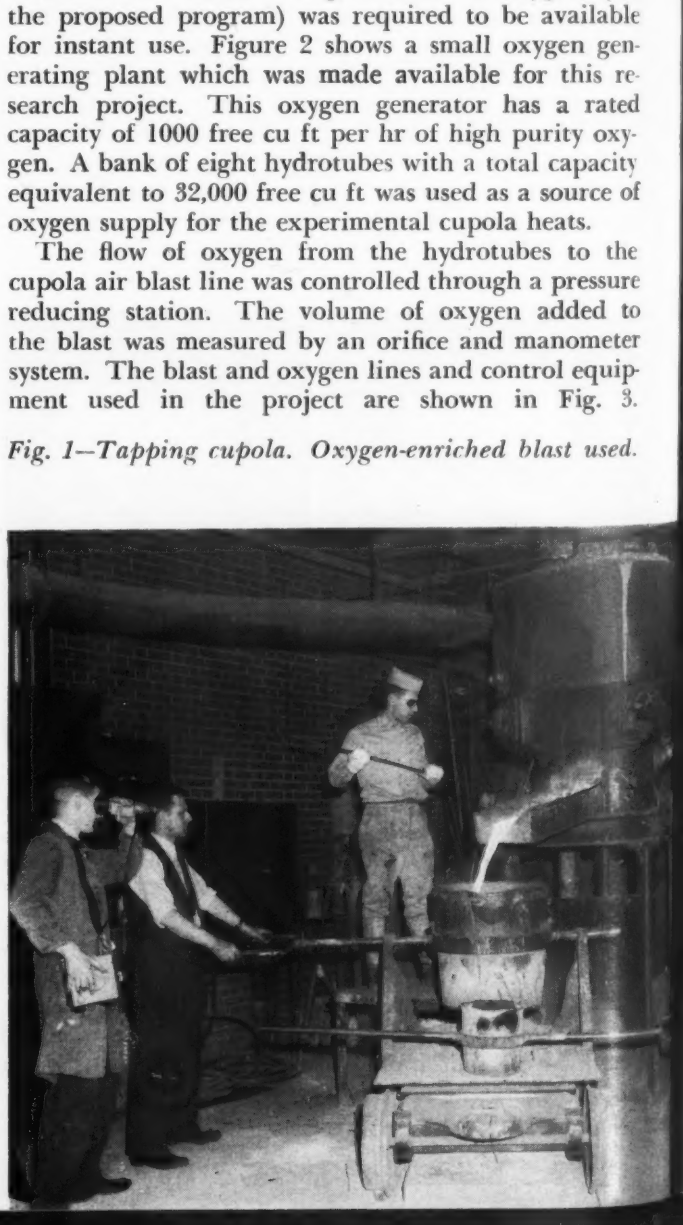
Realizing the importance of the subject, a research project was initiated to determine the advantages or disadvantages that would be obtained from using oxygen-enriched air blasts in the cupola, and to obtain experimental data which would be presented to the foundry industry as an indication of the results that could be expected in commercial operations. In order to obtain such data, a number of heats had to be made with as many constant conditions as possible, using the oxygen content of the air blast and the coke ratio as the controllable variables.

The following presentation is offered as a progress report of the work completed on the use of oxygen-enriched cupola blasts. A number of results are indicated, all of which undoubtedly will be subject to some degree of change when applied to larger scale operation.

Equipment used in the experiments consisted of commercially available items of standard types and design. Figure 1 shows the cupola in operation, tapping an oxygen-enriched blast heat. Because of the nature of the work, a large volume of oxygen (for the proposed program) was required to be available for instant use. Figure 2 shows a small oxygen generating plant which was made available for this research project. This oxygen generator has a rated capacity of 1000 free cu ft per hr of high purity oxygen. A bank of eight hydrotubes with a total capacity equivalent to 32,000 free cu ft was used as a source of oxygen supply for the experimental cupola heats.

The flow of oxygen from the hydrotubes to the cupola air blast line was controlled through a pressure reducing station. The volume of oxygen added to the blast was measured by an orifice and manometer system. The blast and oxygen lines and control equipment used in the project are shown in Fig. 3.

Fig. 1—Tapping cupola. Oxygen-enriched blast used.



Preprint No. 48-38. This paper was presented at a Gray Iron Session of the 52nd Annual Meeting, American Foundrymen's Association, in Philadelphia, May 3-7, 1948.

Fig. 2—Oxygen generating plant used in this project.

A standard type cupola, lined to 19 in. inside diameter, with a skip hoist charging unit was used in the experiments. The air blast entering the cupola was controlled by an air weight control assembly which operated independently from the oxygen pressure reducing station. In order to obtain a thorough mixture of the high purity oxygen addition with the air blast, a 3-in. diameter oxygen line was connected to the 10-in. diameter blast line downstream from the air control assembly and at right angles to the air blast line. So far as could be determined by gas analysis made of samples taken at the wind box, the blast air and oxygen were thoroughly mixed before entering the tuyeres.

Consistency and repetition of a number of procedures from one heat to the other was highly desirable to eliminate as many variable conditions as possible from the tests.

Cupola Operation

Charging practices were standardized for all heats. Two hundred-pound metal charges consisting of 50 per cent pig iron, 40 per cent iron foundry returns and 10 per cent steel flashings were used. When a change in iron to coke ratio was made, the quantity of coke was varied. This represented the smallest change in stock conditions and metal weight adjustments. Raw materials for the experiments were obtained from the same source for all the experiments; however, slight variations in coke and metal quality could not be avoided because of present day material shortages.

Coke for these heats was sized to range from 2 to 4-in. diameter pieces. Limestone was used as the fluxing material in all but two heats and constituted 32 per cent by weight of the coke charge. The air blast was drawn from inside the foundry which maintained a substantially constant temperature range. The oxygen used was of 99.5 to 99.6 per cent purity and free of moisture. Temperature measurements were made inside the cupola with a radiamatic pyrometer sighted into a closed-end ceramic tube immersed in the cupola well. Optical pyrometer temperature readings were taken at the cupola spout throughout each heat. These temperatures form the basis for the data and the results presented.

Research Program and Results Obtained

In order to have a basis for comparison, the initial heats Nos. 1 and 2 were made with a normal oxygen content air blast. Heat No. 2 (Table 1) is considered to be an average operation for this cupola with an 8:1 coke ratio and normal volume air blast of 850 cfm. The melting rate, melting loss and level off temperature were used for comparison with those of the heats made later.

Table 1 is a tabulation of data obtained from individual heats made with varying oxygen additions to the air blast. A series of 8:1 coke ratio heats with oxygen additions to the blast ranging from 0 to 13.8 per cent of the total blast volume show almost a straight line increase in the melting rate. Figure 4 illustrates this increase in melting rate graphically and serves to demonstrate one of the effects of oxygen-enriched cupola blasts. The melting rate was increased as much as 40 per cent in one case. The total blast volume was higher in this heat, which probably had some effect on the melting rate. One of the most satisfactory oxygen-enriched blast heats was No. 4, Table 1, in which the melting rate was increased 19 per cent above the blank heat (No. 2). If the "level off"* tem-

* Level off tapping temperature is the average temperature obtained after the coke bed is burned down to the operating level and the temperature remains nearly uniform.

perature is noted for the various 8:1 coke ratio heats tabulated, a temperature rise will be indicated corresponding to the increase in oxygen content of the blast. Still higher tapping temperatures can be obtained with an 8:1 coke ratio if the total blast volume is reduced 15 to 20 per cent and the oxygen content maintained at approximately a 10 per cent addition. Under these conditions the melting rate will not be increased as much as with the normal blast volume heats with equivalent oxygen additions. Table 1, heat No. 13, shows the figures derived from a reduced volume, oxygen-enriched blast heat. The melting rate, however, is still 5.9 per cent above the blank heat. This combination of conditions should be appealing to a shop interested in higher tapping temperature rather than to one desiring greater production.

Oxidation Losses

Contrary to expectations, oxidation losses diminished with increased oxygen content blasts. If the melting loss and oxygen content of the blast are plotted, the relationship is essentially a straight line function, the melting loss being reduced as the oxygen content of the blast increases. In an effort to determine why the melting loss diminished, metal and slag samples were analyzed. The metal analyses generally indicated silicon content increases rather than the normal 10 per cent loss. This is brought about by increased quantities of CO in the combustion reactions and the formation of slightly reducing conditions shown by flue gas analyses. The results of these conditions are to eliminate the oxidation loss of silicon and also to reduce some of the silica lining to silicon.

Further support of the reduction in melting loss with increased oxygen blast heats is shown in Table 2. Slag analysis of samples taken from the heats Nos. 2, 3 and 4 indicated reductions in manganese, manganese dioxide, and iron oxide contents as the oxygen of the blast is increased. A reduction of these elements in the slag reflects the increased yield of metal charged. Heats Nos. 6 and 13 show the same trend for the iron oxide but because of other changes in the heat the other elements are slightly out of line with the indicated trend.

Referring again to Table 1, the effect of oxygen enrichment and reduced volume blasts with a 12:1 coke ratio is shown. By a simple change in the total blast volume, maintaining the same percentage of oxygen addition, the melting rate can be reduced and the tapping temperature increased. This method of control offers a greater flexibility in cupola operation.

Effect of Oxygen Content and Coke Ratio

Several heats using a 5:1 coke ratio and normal oxygen content air blast were made for comparative purposes with the 7:1 and 8:1 coke ratio enriched blast heats. Operations with the 5:1 ratio heat (No. 11) were very unsatisfactory due to the high ash con-

Fig. 3—Blast and oxygen lines, and control equipment.

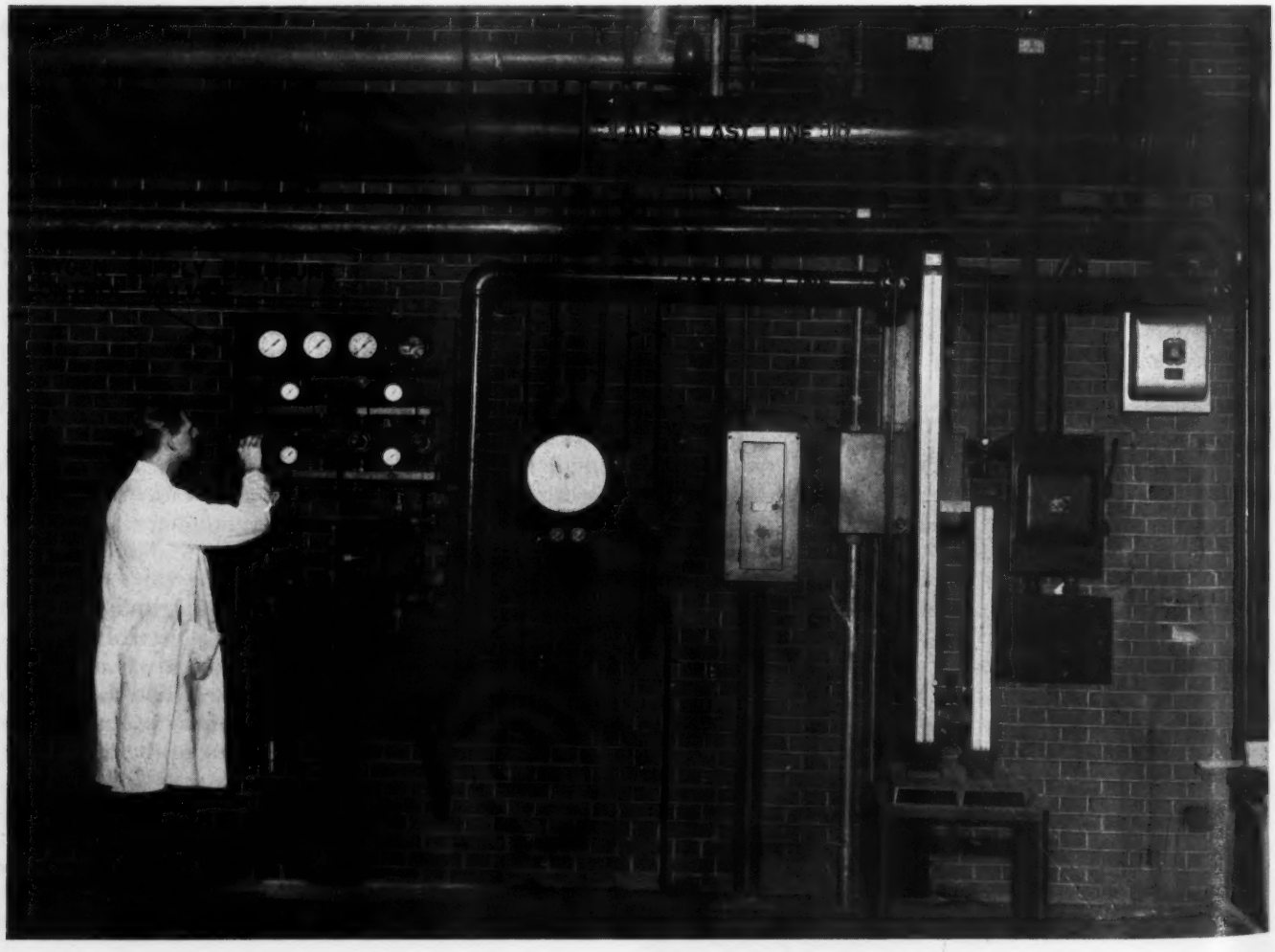


TABLE 1—COMPARATIVE DATA, NORMAL AND OXYGEN ENRICHED BLAST HEATS

Heat No.	Melting Time (min)	Melting Rate (lb/hr)	Coke Ratio	Total Blast Volume (cfm)	Oxygen Addition (% of Blast)	Level Off Average Temp. (°F)	Metal Charged (lb)	Metal Melted (lb)	Metal Re-Covered (lb)	Melting Loss (%)	Increased Melting Rate (%)	Remarks
2	115	2922	8–1	850	0	2675	5800	5600	5250	6.3	0	
3	113	3186	8–1	860	4.5	2700	6000	6000	5713	4.8	9.0	
4	100	3600	8–1	850	8.6	2775	6000	6000	5775	3.8	19.4	
6	82	4098	8–1	892	13.8		6000	5600	5596	0.07	40.2	Booster Charge of Coke Added During Heat—No Level Off
13	103	3096	8–1	700	9.9	2860	6000	5317	5191	2.3	5.9	
7	95	3789	12–1	817	8.2	2650	6000	6000	5825	2.9		
14	120	3200	12–1	550	8.1	2800	6400	6400	6362	0.6		
8	119	3000	7–1	850	8.7	2810	6000	5921	5835	1.5		
12	179	1836	5–1	850	0	2600	6000	5486	5389	1.6		
11	147	1956	5–1	850	0		4800	4800				Oxygen Used to Save Heat
				750	8.0							
				700	9.4							
15	104	3228	8–1	850	0	2790	5600	5600	5473	2.2	10.7	
				670	7.1							

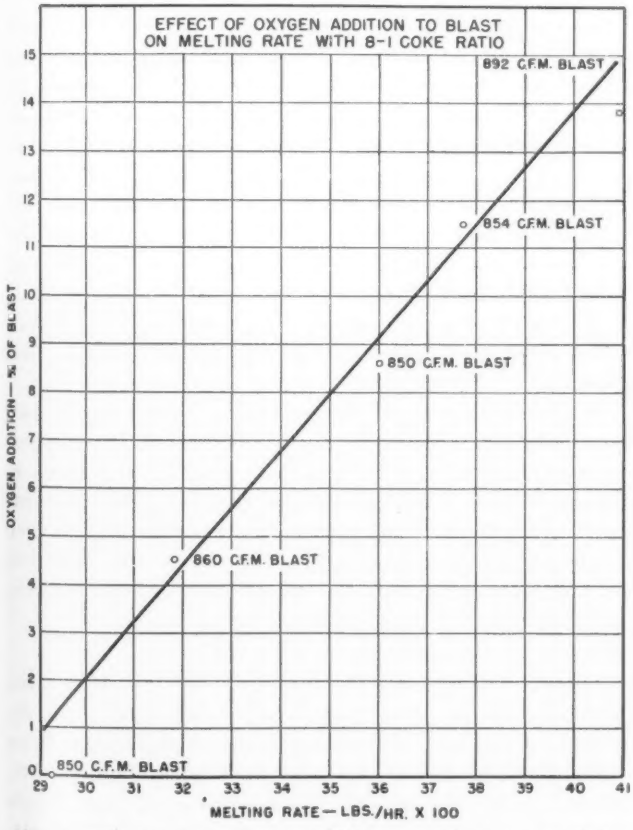


Fig. 4—Effect of oxygen addition to blast on melting rate with 8:1 coke ratio.

tent of the coke. A study of Table 1 will reveal that higher temperatures and faster melting rates were obtained with a 12:1 coke ratio oxygen-enriched blast than was possible with a 5:1 ratio normal volume air blast. Savings of fuel (and even salvage of a complete heat in some instances) can be effected without a sacrifice in vital temperature requirements. The amount of fuel saved would be the difference between the 5:1 and 12:1 coke ratios or approximately 233 lb of coke per ton of metal melted. The increased temperature and melting capacity of these two heats must likewise be considered when weighing the economics of each operation.

Comparison of heats Nos. 7 and 14, Table 1, indicates similar temperature and melting rate results. Economically, however, heat No. 14 would be more desirable than No. 7 because of the smaller quantity of coke and oxygen used and decreased melting loss for a comparable tapping temperature and melting rate.

Another economic aspect to be considered when thinking of the oxygen-enriched blast is the effect it might have on the cupola refractory. A quantitative study of lining loss during each heat was made and the results are shown in Table 3. The patch material used in all heats was as follows: 30 per cent—1/8-in. silica quartz ganister; 50 per cent—3/8-in. silica quartz ganister; 14 per cent—No. 60 silica sand; 6 per cent—western bentonite; 5 per cent water.

The data given represent the quantity of patch

TABLE 2—SLAG ANALYSIS FROM 8:1 COKE RATIO HEATS

Heat No.	Oxygen Addition (% of Blast)	Si	SiO_2	Mn	MnO_2	FeO	Remarks
2	0	22.0	47.1	1.53	2.41	6.3	
3	4.5		47.4	1.43	2.26	4.4	
4	8.6		53.8	1.32	2.08	3.0	
		23.24	49.7	0.86	1.36	3.87	Excessive O_2 for
6	13.8	23.00	49.2	1.45	2.29	6.10	Coke Used
		20.92	44.78	1.90	3.00	1.47	Reduced
13	9.9	21.46	45.93	2.11	3.34	1.74	Volume Blast

material of a constant quality and mixture required to restore the inside diameter of the cupola to 19 in. Dimensionally speaking, the oxygen-enriched blast can be considered less destructive to the lining than the normal blast. However, the zone of maximum temperature is extended or elongated, which also means the "scar" or burned out area is increased accordingly. This condition accounts for the apparent added lining loss in the oxygen-enriched heats. It is possible that, due to the slight decrease in dimensional loss of the lining, longer heats could be run if desirable. Close observation of the quantities of patch material listed in Table 3 will reveal that the reduced blast volume heat No. 13, (oxygen enriched) caused less lining damage dimensionally and volumetrically than the normal oxygen blast heats. Heat No. 14, also of reduced volume enriched blast, was slightly more destructive to the lining than the blank heat. Heat No. 15 was a mixed blast heat which was changed from normal to oxygen-enriched blasts intermittently during the heat. This procedure was not particularly harmful to the lining and did show interesting effects of periodic usage of oxygen-enriched blasts for controlling temperature.

Mere tabulation of the data from these heats is insufficient to emphasize the importance of the developments which are possible by the use of oxygen-enriched blasts. The more interesting and valuable aspects of this research program are brought out by a brief discussion of the various figures which are shown herewith.

Temperature Control With Oxygen and Coke Ratios Required

Figure 5 represents tapping temperature curves from Heats Nos. 2, 3, and 4. The value of oxygen enrichment in the raising of tapping temperatures is illustrated. Using normal blast volumes, an oxygen addition of 8.6 per cent was sufficient to increase the metal temperature at the spout 100 F. This amount of added temperature would be helpful in eliminating misrun defects if such conditions prevailed.

If little or no extra temperature is required, oxygen enrichment will be effective in reducing the quantity of coke required per ton of metal melted. Figure 6 shows the similarity of results that can be obtained by the use of a 12:1 coke ratio and an 8.2 per cent oxygen addition to the blast as compared with a heat of 8:1 coke ratio and normal oxygen content air blast.

Another method of temperature control is demonstrated in Fig. 7. Manipulation of the coke ratio with approximately the same total blast volume and oxygen addition will result in raised or lowered tapping temperatures. This condition, if known to the cupola operator, could be used to great advantage in producing iron at the most suitable temperature for the type of work to be poured. Greater economy of coke consumption can be obtained if oxygen is used to control the tapping temperature.

"Oxygen as Cupola Medicine"

Figure 8 emphasizes the importance and value of oxygen-enriched blasts when a heat gets off to a poor start or when below average fuel is encountered unexpectedly. Heat No. 11 illustrates the action of a 5:1 coke ratio normal oxygen content blast heat which started out under average conditions. About half way through the heat, the temperature started to drop and severe bridging occurred. The heat was losing temperature steadily and under ordinary circumstances the bottom would have been dropped, thereby losing the balance of the day's run. Knowing the potentialities of oxygen, the blast was enriched and almost immediately the temperature increased. The balance of the heat was completed without additional difficulty. The coke analysis indicated a high ash content which was blamed for most of the trouble encountered. Another brand of coke with a lower ash and higher carbon content was used for heat No. 12 and the results were somewhat better with the same coke ratio and normal blast as that used in heat No. 11.

TABLE 3—LINING MATERIAL REQUIRED AFTER VARIOUS HEATS

Heat No.	Lining Diameter After Heat (Inches)	Patch Material Required (Pounds)	Coke Ratio	Oxygen Addition (% of Blast)
2	25	210	8–1	0
3	25	245	8–1	4.5
4	25½	275	8–1	8.6
6		290	8–1	13.8
7	24	275	12–1	8.2
8	22	225	7–1	8.7
*11		350	5–1	0
*12	27	490	5–1	0
13	22	90	8–1	9.9
14	22	225	12–1	8.1
15	23	215	8–1	Variable

* Soda Ash+Limestone Flux.

The importance of these results cannot be stressed too strongly, especially to the small shop operator who occasionally may get into trouble and have to "drop bottom." For such cases as these, the economy and advantages of having a few cylinders of oxygen available for emergency use is immeasurable. The loss of a day's production can mean many times the cost of ten or twenty small tanks of oxygen.

Reduced Volume Blasts

Figure 9 compares the results of a 7:1 coke ratio, normal volume oxygen-enriched blast heat (No. 8) with two reduced volume oxygen-enriched blast heats (Nos. 13 and 14) of 8:1 and 12:1 coke ratio, respectively. Aside from a slight bridging of one tuyere during heat No. 14, which caused a temperature variation, approximately the same accomplishment was possible with a 12:1 coke ratio reduced volume enriched blast heat as with a 7:1 coke ratio normal volume enriched blast heat. The 8:1 coke ratio heat was slightly hotter and more uniform in tapping temperature than either of the other two heats. The significant feature of this particular illustration is the demonstration of the ability to produce hotter iron with less coke using reduced volume oxygen-enriched blasts than is possible with normal volume blasts even with added oxygen. The only important variable that could cause such a variation in operating conditions is the quantity of inert nitrogen entering the cupola. Nitrogen adds nothing to the combustion of

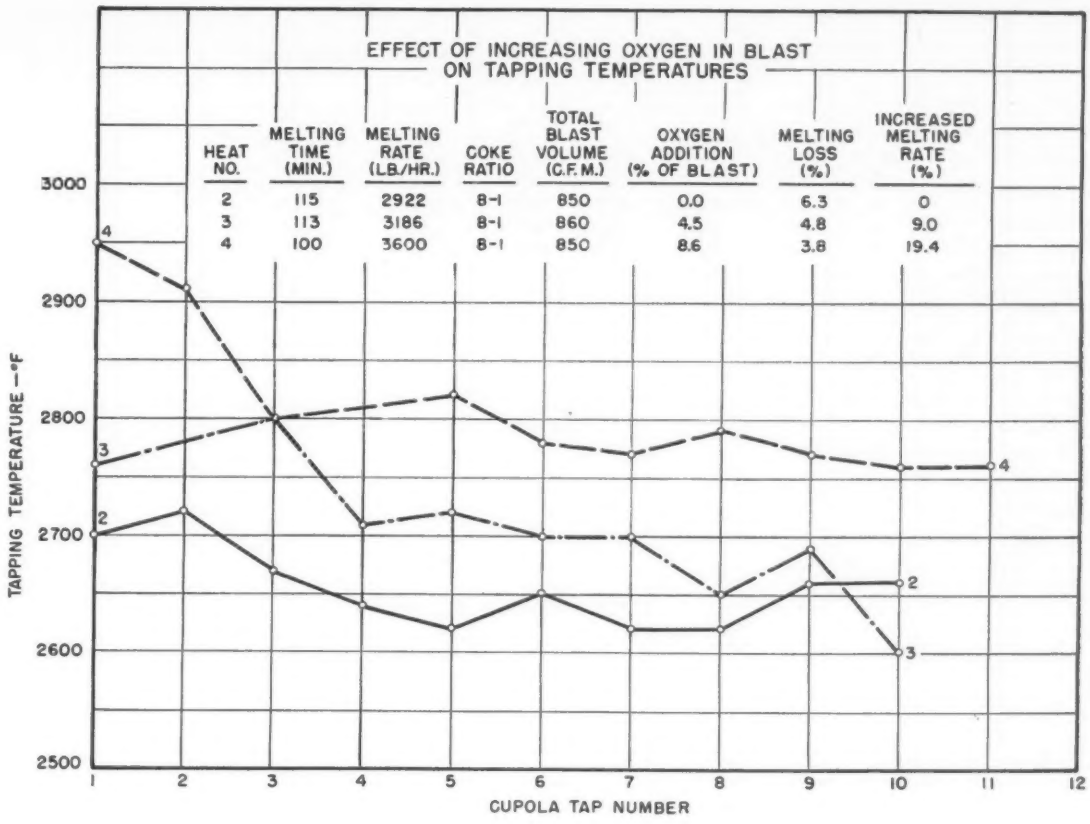

EFFECT OF INCREASING OXYGEN IN BLAST
ON TAPPING TEMPERATURES
HEAT NO. | MELTING TIME (MIN.) | MELTING RATE (LB/HR.) | COKE RATIO | TOTAL BLAST VOLUME (C.F.M.) | OXYGEN ADDITION (% OF BLAST) | MELTING LOSS (%) | INCREASED MELTING RATE (%)
2 | 115 | 2922 | 8-1 | 850 | 0.0 | 6.3 | 0
3 | 113 | 3186 | 8-1 | 860 | 4.5 | 4.8 | 9.0
4 | 100 | 3600 | 8-1 | 850 | 8.6 | 3.8 | 19.4
TAPPING TEMPERATURE — °F
3000
2900
2800
2700
2600
2500
1 2 3 4 5 6 7 8 9 10 11 12
CUPOLA TAP NUMBER

Fig. 5—Effect of increasing oxygen in blast on tapping temperatures.

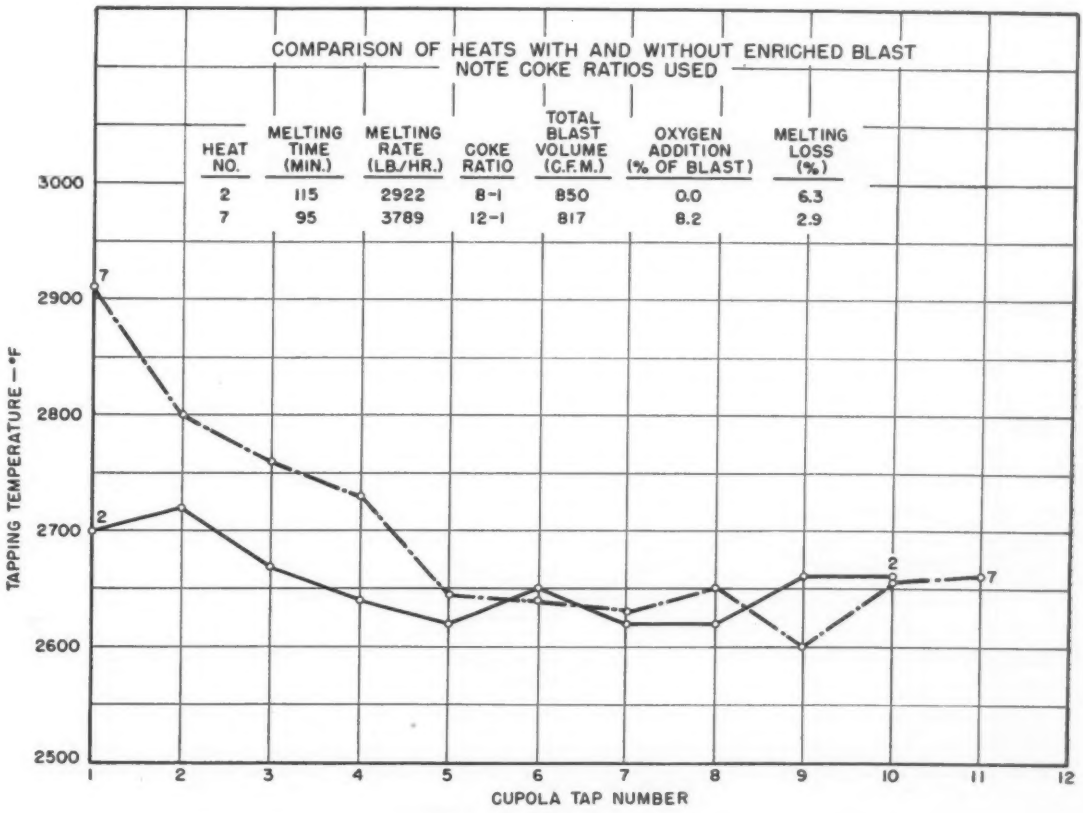

COMPARISON OF HEATS WITH AND WITHOUT ENRICHED BLAST
NOTE COKE RATIOS USED
HEAT NO. | MELTING TIME (MIN.) | MELTING RATE (LB/HR.) | COKE RATIO | TOTAL BLAST VOLUME (C.F.M.) | OXYGEN ADDITION (% OF BLAST) | MELTING LOSS (%)
2 | 115 | 2922 | 8-1 | 850 | 0.0 | 6.3
7 | 95 | 3789 | 12-1 | 817 | 8.2 | 2.9
TAPPING TEMPERATURE — °F
3000
2900
2800
2700
2600
2500
1 2 3 4 5 6 7 8 9 10 11 12
CUPOLA TAP NUMBER

Fig. 6—Comparison of heats with and without enriched blast.

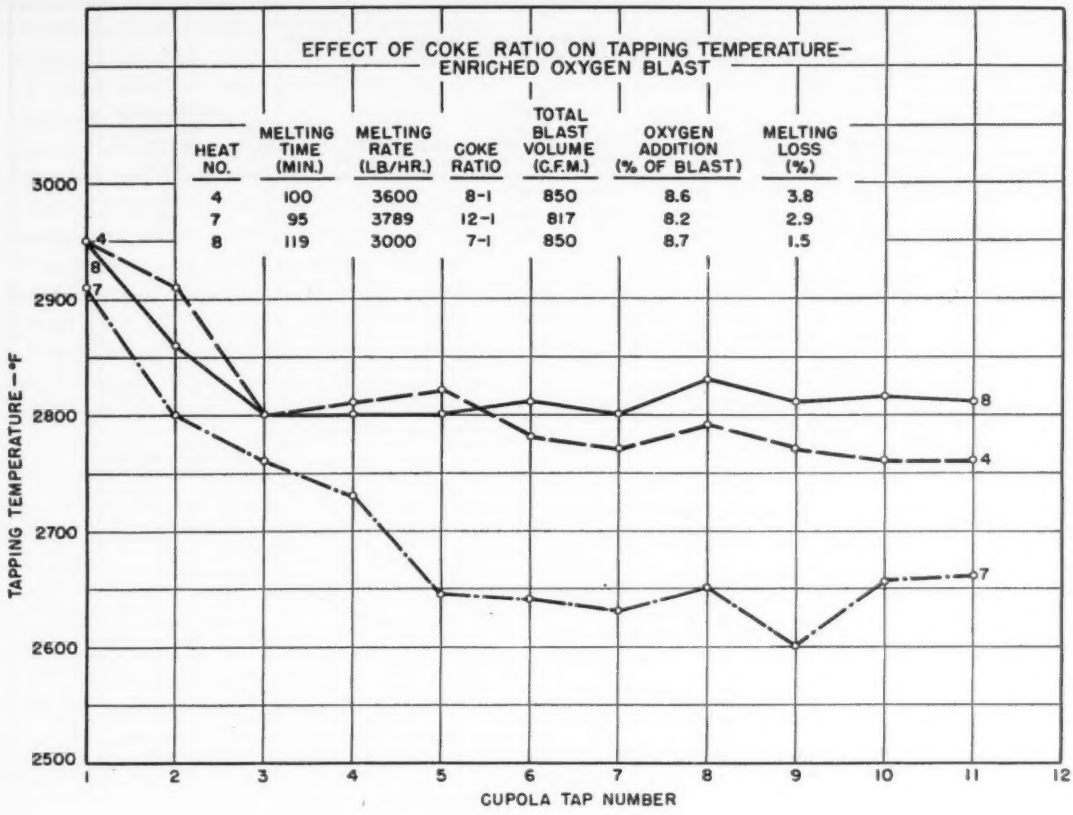

EFFECT OF COKE RATIO ON TAPPING TEMPERATURE–
ENRICHED OXYGEN BLAST
HEAT NO. | MELTING TIME (MIN.) | MELTING RATE (LB/HR.) | COKE RATIO | TOTAL BLAST VOLUME (C.F.M.) | OXYGEN ADDITION (% OF BLAST) | MELTING LOSS (%)
4 | 100 | 3600 | 8-1 | 850 | 8.6 | 3.8
7 | 95 | 3789 | 12-1 | 817 | 8.2 | 2.9
8 | 119 | 3000 | 7-1 | 850 | 8.7 | 1.5
TAPPING TEMPERATURE – °F
3000
2900
2800
2700
2600
2500
1 2 3 4 5 6 7 8 9 10 11 12
CUPOLA TAP NUMBER

Fig. 7—Effect of coke ratio on tapping temperature—enriched oxygen blast.

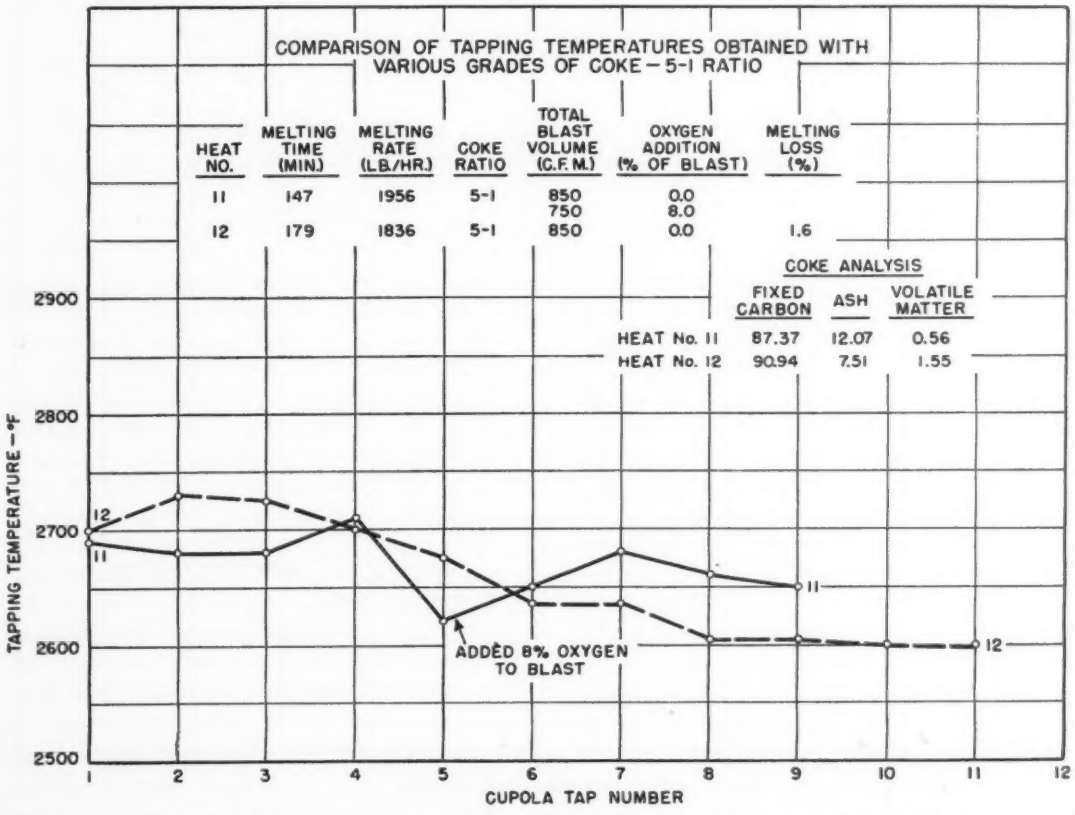

COMPARISON OF TAPPING TEMPERATURES OBTAINED WITH
VARIOUS GRADES OF COKE – 5-1 RATIO
HEAT NO. | MELTING TIME (MIN.) | MELTING RATE (LB/HR.) | COKE RATIO | TOTAL BLAST VOLUME (C.F.M.) | OXYGEN ADDITION (% OF BLAST) | MELTING LOSS (%)
11 | 147 | 1956 | 5-1 | 850 / 750 | 0.0 / 8.0 |
12 | 179 | 1836 | 5-1 | 850 | 0.0 | 1.6
COKE ANALYSIS
FIXED CARBON | ASH | VOLATILE MATTER
HEAT No. 11 | 87.37 | 12.07 | 0.56
HEAT No. 12 | 90.94 | 7.51 | 1.55
TAPPING TEMPERATURE – °F
2900
2800
2700
2600
2500
ADDED 8% OXYGEN TO BLAST
1 2 3 4 5 6 7 8 9 10 11 12
CUPOLA TAP NUMBER

Fig. 8—Comparison of tapping temperatures obtained with various grades of coke—5:1 ratio.

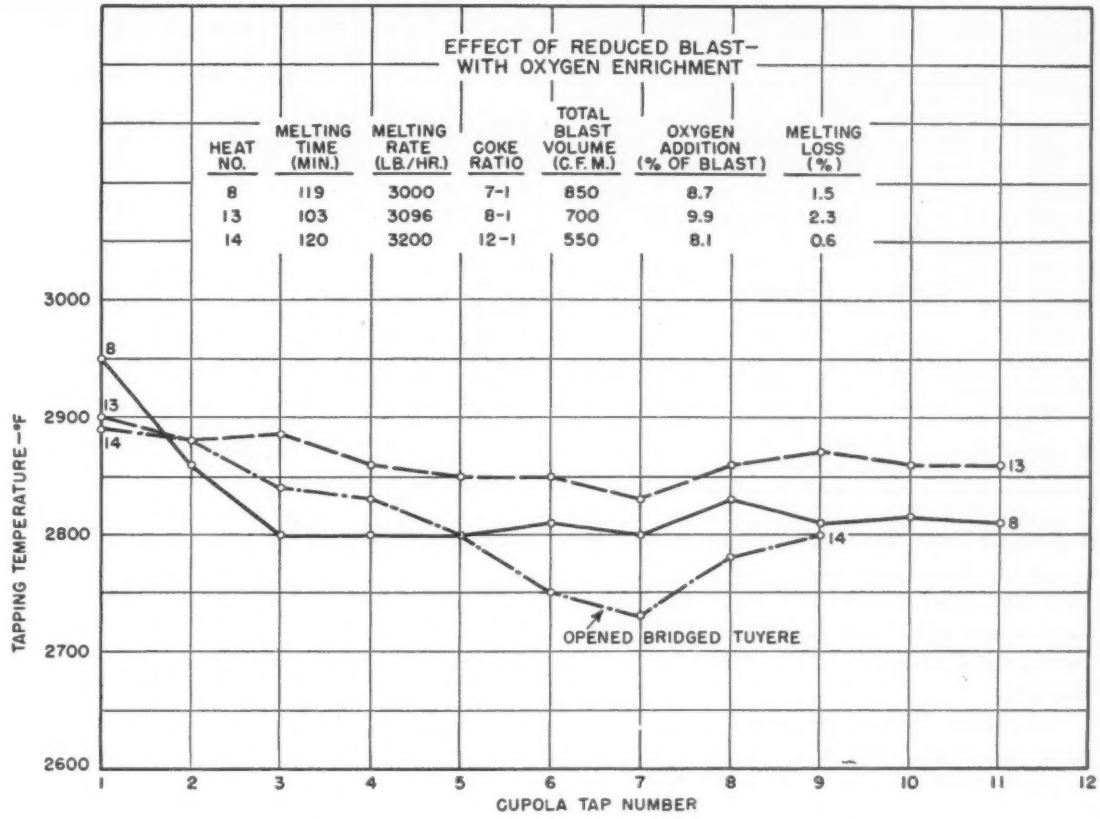

EFFECT OF REDUCED BLAST–
WITH OXYGEN ENRICHMENT
HEAT NO. | MELTING TIME (MIN.) | MELTING RATE (LB./HR.) | COKE RATIO | TOTAL BLAST VOLUME (C.F.M.) | OXYGEN ADDITION (% OF BLAST) | MELTING LOSS (%)
8 | 119 | 3000 | 7-1 | 850 | 8.7 | 1.5
13 | 103 | 3096 | 8-1 | 700 | 9.9 | 2.3
14 | 120 | 3200 | 12-1 | 550 | 8.1 | 0.6
TAPPING TEMPERATURE – °F
3000
2900
2800
2700
2600
OPENED BRIDGED TUYERE
1 2 3 4 5 6 7 8 9 10 11 12
CUPOLA TAP NUMBER

Fig. 9—Effect of reduced blast with oxygen enrichment.

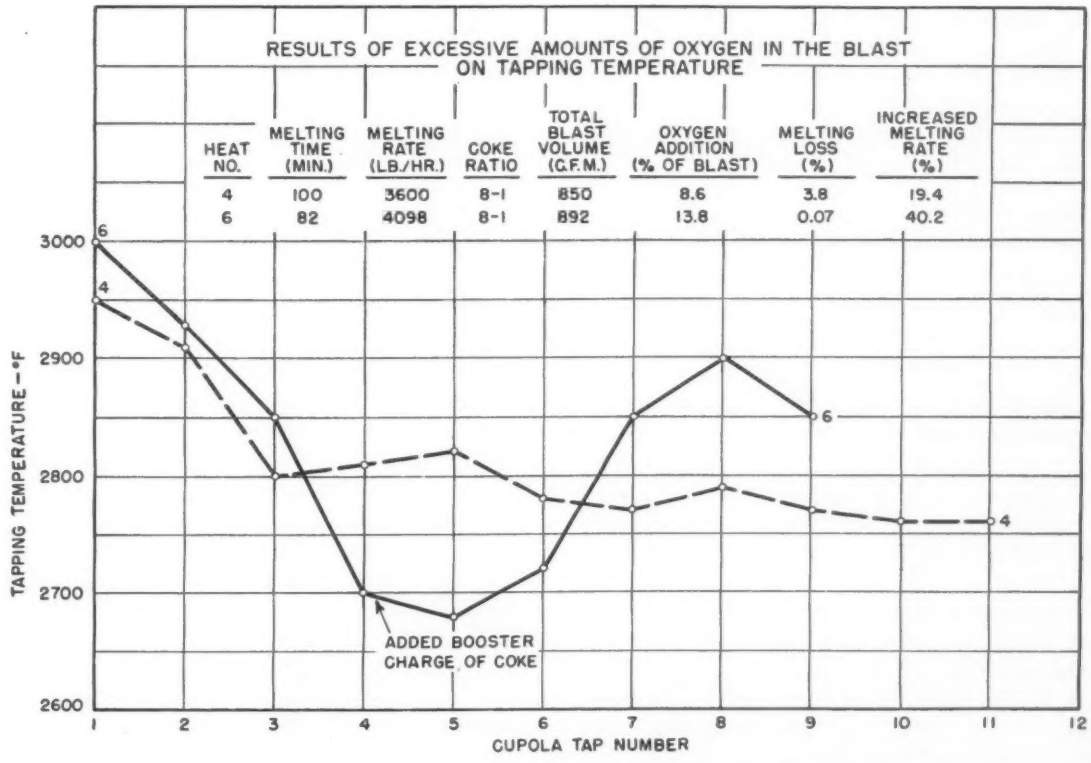

RESULTS OF EXCESSIVE AMOUNTS OF OXYGEN IN THE BLAST
ON TAPPING TEMPERATURE
HEAT NO. | MELTING TIME (MIN.) | MELTING RATE (LB./HR.) | COKE RATIO | TOTAL BLAST VOLUME (C.F.M.) | OXYGEN ADDITION (% OF BLAST) | MELTING LOSS (%) | INCREASED MELTING RATE (%)
4 | 100 | 3600 | 8-1 | 850 | 8.6 | 3.8 | 19.4
6 | 82 | 4098 | 8-1 | 892 | 13.8 | 0.07 | 40.2
TAPPING TEMPERATURE – °F
3000
2900
2800
2700
2600
ADDED BOOSTER CHARGE OF COKE
1 2 3 4 5 6 7 8 9 10 11 12
CUPOLA TAP NUMBER

Fig. 10—Results of excessive amounts of oxygen in the blast on tapping temperature.

TABLE 4—OXYGEN ADDITIONS VS. INCREASED MELTING RATES

Cupola Size	Total Blast C.F.M.	Oxygen Addition Cu Ft/Hr Percent of Blast 4	6	8	10	Normal Melting Rate (*) Tons/Hr	Melting Rate — Tons/Hr With Oxygen Addition Percent of Blast (*) 4	6	8	10
1	950	2,280	3,420	4,560	5,700	1.5	1.63x	1.71x	1.78x	1.86x
2	1,300	3,120	4,380	6,240	7,800	2.25	2.44	2.56	2.66	2.78
3	1,800	4,320	6,480	8,650	10,800	3.25	3.54	3.70	3.86	4.03
3½	2,425	5,810	8,760	11,600	14,500	4.25	4.63	4.83	5.05	5.27
4	3,100	7,450	11,100	14,850	18,550	5.50	5.99	6.28	6.5	6.80
5	3,600	8,650	12,920	17,500	21,600	6.25	6.8	7.12	7.45	7.75
6	4,100	9,840	14,720	19,600	24,600	7.25	7.9	8.26	8.6	9.0
7	5,200	12,450	18,650	24,900	31,200	9.25	10.0	10.5	11.0	11.5
8	6,400	15,350	23,000	30,700	38,400	11.25	12.2	12.8	13.3	13.9
9	7,700	18,450	27,600	36,850	46,200	13.75	15.3	15.6	16.3	17.0
9½	9,200	22,050	33,100	44,100	55,100	16.25	17.7	18.5	19.3	20.0
10	10,700	25,600	38,400	51,400	64,250	19.0	21.1	21.6	22.6	23.5
12	12,500	30,000	45,000	60,000	75,000	22.25	24.2	25.3	26.4	27.1

* Based on 8-1 coke ratio.

x Estimated from experimental heats.

the coke to produce heat, but does add an extra volume of gas which must necessarily be heated as it passes through the cupola. The Btu value developed by combustion is partially used to heat this nitrogen, thereby reducing the amount of heat available to melt and superheat the iron.

Excessive Oxygen Addition

The amount of oxygen added to the blast may be in excess of that which can be used satisfactorily for the quantity of coke present in the bed and subsequent splits. A typical example of such a condition was produced in heat No. 6 shown graphically (Fig. 10) in comparison with a satisfactory heat of 8.6 per cent oxygen addition. Both heats represented were made with the same coke ratio (8:1), and approximately the same total blast volume.

An oxygen addition of 13.8 per cent was sufficient to burn the coke faster than melting could proceed; therefore, the coke bed was burned down with an accompanying loss of temperature. Later in the heat, a booster charge of coke was added and the temperature increased until this coke also was burned away. A very high temperature would have resulted if sufficient coke was supplied for the quantity of oxygen present in the blast.

To use oxygen in the blast throughout the entire heat might be considered unnecessary or too costly by some operators. An alternate method of using oxygen that is worthy of consideration is the intermittent "shot in the arm" procedure. Figure 11 shows the effect of periodic additions of oxygen to the blast on tapping temperature. The first part of the heat was run with the "shot in the arm" method and the last part was run using oxygen primarily as a control tool to obtain and maintain a given temperature. The results are self evident of the value of oxygen as a control tool and for quick temperature pick-up to avoid or eliminate bridging or cold iron difficulties.

TABLE 5—COST OF OXYGEN ADDITIONS/TON OF MELT

Cu Ft of Oxygen Per Mo. (20 Days)	Tons of Oxygen Per Mo. (20 Days)	Unit Cost of Oxygen Dollars/Ton	Unit Cost of Oxygen Cents/100 Cu Ft	Dollars Cost/Ton of Melt Per Cent Addition 4	6	8	10
Small Quantity Purchase		180.00	75.0	9.40	13.30	17.20	20.60
Small Quantity Purchase		120.00	50.0	6.25	8.90	11.50	13.70
600,000	25.0	72.00	30.0	3.75	5.35	6.90	8.25
1,200,000	50.0	62.40	26.0	3.25	4.63	5.97	7.16
1,800,000	75.0	55.20	23.0	2.88	4.10	5.30	6.35
3,840,000	160	45.60	19.5	2.44	3.47	4.49	5.35
4,800,000	200	44.40	18.5	2.32	3.29	4.26	5.10
5,760,000	240	43.20	18.0	2.25	3.20	4.14	4.96
6,720,000	280	42.00	17.5	2.19	3.12	4.02	4.82
7,680,000	320	40.80	17.0	2.12	3.02	3.92	4.69
8,640,000	360	39.60	16.5	2.06	2.94	3.80	4.54
9,600,000	400	38.40	16.0	2.00	2.84	3.68	4.41
10,560,000	440	37.20	15.5	1.94	2.76	3.56	4.27
11,520,000	480	37.20	15.5	1.94	2.76	3.56	4.27
15,360,000	640	36.00	15.0	1.87	2.66	3.45	4.14
19,200,000	800	34.80	14.5	1.81	2.58	3.34	4.00
23,040,000	960	33.60	14.0	1.75	2.50	3.22	3.86
Very Large Quantity Purchase		15.00	06.2	0.78	1.11	1.44	1.72
Huge Quantity Purchase		5.00	02.1	0.25	0.36	0.46	0.55

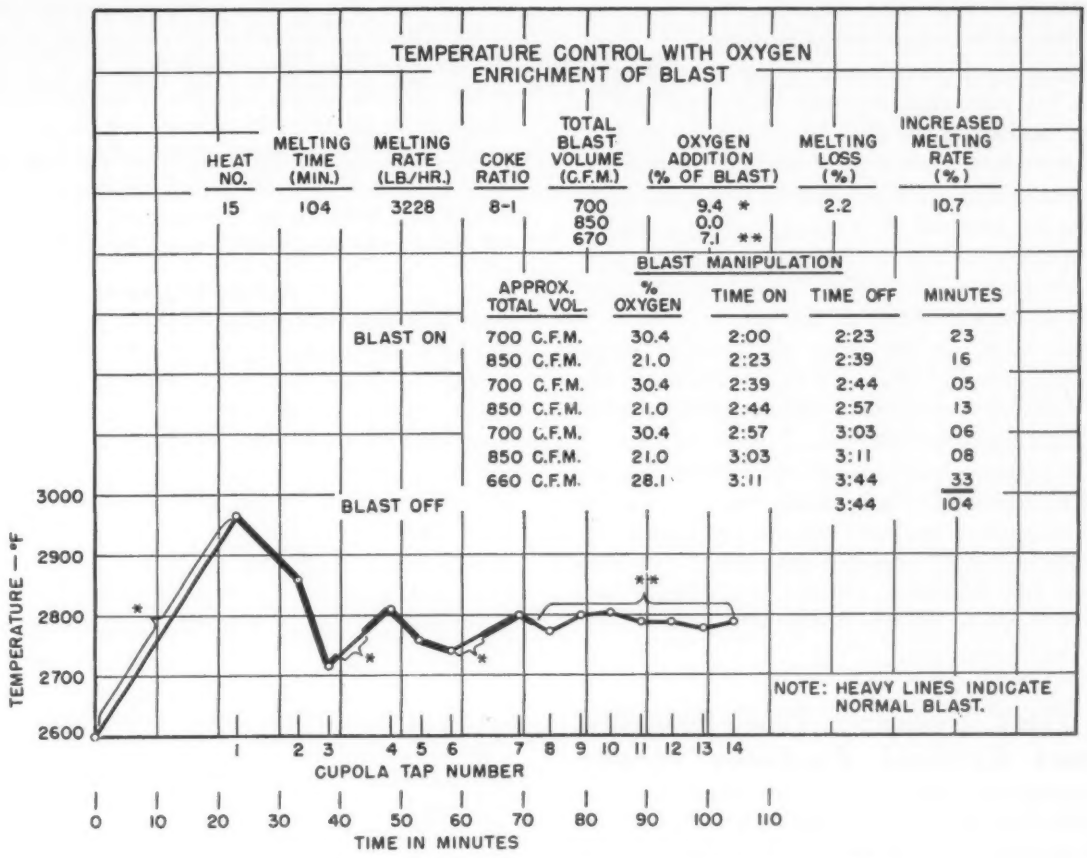


Fig. 11—Temperature control with oxygen enrichment of blast.

Probably the most vital consideration, and naturally the first thought, concerns the economics of the use of oxygen-enriched blasts. The question of the cost of large volume purchases of oxygen has many answers, depending on how much is required, the purity and the method of obtaining it.

Cost of Oxygen Addition to Blast

Since the advantages gained from the use of oxygen in the cupola blast are somewhat intangible economically (fewer misrun castings, improved furnace operation, higher melting rate, less oxidation loss, higher pouring temperatures, etc.), the real value in dollars and cents would be difficult, if not impossible, to evaluate unless savings were calculated over a prolonged period of time.

Table 4 consists of a number of assumed melting rates for various size cupolas using data from the experimental heats as a basis for the calculations.

The melting rate per unit of time will influence the cost per ton of melt when using oxygen in the blast. In normal blast heats with approximately 4, 6, 8, and 10 per cent oxygen additions to the blast, the melting rates were increased by roughly 9, 14, 19, and 24 per cent, respectively. Using these approximations derived from the experimental heats, a table (No. 4) of oxygen consumption per hour and melting rate per hour was prepared for various sized cupolas.

Table 5 shows approximate costs of quantity oxygen at various levels of consumption per month as supplied by one of the leading makers of oxygen production equipment. The cost of using oxygen per ton of melt at four levels of addition are indicated for the unit cost represented. These costs are only approximations and will vary according to the source of oxygen supply.

The real cost of oxygen-enriched cupola blasts as stated previously will depend on the amount of help it will offer to the particular foundry, and it is believed may be more than balanced by economies in operation, if effectively used.

Conclusions

The following conclusions have been drawn from the experimental data obtained from the use of oxygen additions to the cupola blast.

1. With approximately a 10 per cent oxygen addition to the normal volume cupola blast and an 8:1 coke ratio, the melting rate was increased roughly 20 per cent.

2. Under the above conditions the tapping temperature of the metal was approximately 100 F higher than with a normal oxygen content blast. Higher operating temperatures also provided less bridging and more fluid slag.

3. By control of the oxygen content and total volume of the blast, tapping temperature and melting rate for a given coke ratio can be controlled to suit the prevailing conditions in cupola operation.

4. Oxygen additions of more than 10 per cent of

the total blast require a low coke ratio and would result in high tapping temperatures.

5. Temperature control by adjustment of the coke ratio is possible with oxygen-enriched blasts.

6. Operating conditions and tapping temperatures similar to a 5:1 coke ratio normal blast heat can be obtained by increasing the iron to coke ratio to 12:1 and adding from 8 to 9 per cent of oxygen to the blast.

7. Reduced volume oxygen-enriched cupola blasts caused a smaller increase in melting rate and higher tapping temperature than the normal volume oxygen-enriched blast heats. This offers an additional tool for temperature and production control.

8. Periodic "shot in the arm" methods of using oxygen additions to the blast can be beneficial in obtaining hot iron on short notice without serious interruption of the charging routine.

9. Cupola heats that start to freeze up due to some operating difficulty, (poor coke, bridging, etc.), can be saved from "dropping bottom" by the emergency use of bottled oxygen added into the blast line. The temperature can be increased almost immediately and the heat saved, not to mention the day's production.

10. By proper manipulation and use of oxygen-enriched blasts, little additional refractory loss occurred and improved operating conditions resulted.

11. Less oxidation loss of the silicon occurred with the use of oxygen-enriched blasts.

12. Dollars and cents cost of oxygen additions will range from $0.25 to $20.00 per ton of melt depending upon quantity added and price paid per 100 cu ft. The true cost or economy of oxygen-enriched cupola blasts will have to be determined by each shop after all conditions of operation are considered.

Acknowledgments

The author wishes to express his appreciation to the Whiting Corporation, Harvey, Illinois, for sponsoring the research work, and to Air Products Incorporated, Emmaus, Pennsylvania, for the use of the oxygen generating unit. Special acknowledgment and appreciation goes to A. W. Gregg, P. Poelstra, W. Jaeschke, and A. J. Grindle of the Whiting Corporation, Harvey, Illinois; and to W. E. Mahin, R. D. Haworth, C. Locke, M. Baeyertz, and other staff members of Armour Research Foundation for their interest and assistance in the completion of the reported work.

Expect First Swedish Pipe Foundry To Offset Critical Post-war Needs

Sweden's first pipe foundry, AB Centrifugal-ror, has been established at the ice-free port of Oxelosund, 90 miles south of Stockholm, in the vicinity of Oxelosund Iron Works, Sweden's largest supplier of pig iron.

The ABC pipe foundry is designed to meet the need for Swedish self-sufficiency in the production of cast iron pipe, and is primarily the result of a critical post-war shortage.

The new foundry, purchased by government co-operative organizations, is situated along the main ore railway to the Ironworks, about 1500 ft from the smelters, and its pig iron supply is delivered direct from the foundry by rail.

Operating by the Arens method, the ABC works is laid out for an initial capacity of about 30,000 tons a year. Four cupolas, each with a maximum capacity of about 10 tons per hr, are bucket charged directly from the railway siding, and are operated alternately, two for each day's run.

The molten metal is poured into transfer ladles and transported to two batteries of centrifugal casting machines, consisting of three machines capable of producing 16-ft pipe varying in diameter from 8 to 16 in, and two 13-ft machines for somewhat smaller pipe diameters. The second battery consists of five machines for 6½-ft drain pipe of 2½ in., 3 in. and 4 in. diameters.

After being pulled and weighed the pipe passes through the continuous oil-fired, automatically- controlled annealing furnace. The pipe travels by finger conveyor and the thermostatically controlled furnace operates at 1650 F.

Emerging from the cooling zone of the normalizing furnace, the pipe rolls on a three-rail cooling track to the cleaning and grinding stations. It is then heated for efficient coating.

Swedish standards permit hydrostatic testing subsequent to the tar dip and the pipe is accordingly conveyed to the testing sheds, where each one is head clamped and subjected to a water-pressure of 280 psi and a simultaneous impact test by hammer.

From the testing sheds the pipe rolls on an inclined six-rail track towards the railway siding. The storage area is equipped with two lateral distribution tracks to facilitate makeup of deliveries.

The entire plant is Swedish built according to a license agreement with the Swiss firm of Ludwig Rollsche Eisenwerke AG.

Steel Founders' Society Announces Election Of Officers For 1948-1949

F. KERMIT DONALDSON, Machine Steel Casting Co., Alliance, O., was elected president of the Steel Founders' Society of America at the society's annual meeting, held at the Edgewater Beach Hotel, Chicago.

Other officers elected for the 1948-49 season are: *vice president,* B. P. Hammond, Continental Foundry & Machine Co., Pittsburgh; re-elected *treasurer,* Keith Williams, Pratt & Letchworth Co., Inc., Buffalo, N.Y.; *executive vice president and secretary,* Leslie C. Thellemann; *technical and research director,* Charles W. Briggs.

The Society's Lorenz Medal, for outstanding contributions to the Society and to the progress of the steel castings industry was awarded E. D. Flintermann, president of the Michigan Steel Casting Co., Detroit, immediate past president of the society.

The Steel Founders' Technical and Operating Medal was awarded to Charles L. Heater, vice-president, American Steel Foundries, Chicago, for his work as chairman of the Steel Founder's Society Technical Research committee.

The Society is currently sponsoring 13 research projects of which it is expected that 11 will be completed and reported this year, it was announced by Technical Director Briggs.

FEEDING CASTINGS

A New Approach

S. T. Jazwinski
Vice President
Sheffield Iron & Steel Co.
Sheffield, Ala.

IN THE PAST, the production of castings was regarded largely as an art, and depended primarily upon craftsmanship and skill. Today, castings must be made on a basis of competition with constantly developing methods in the various metal fabricating fields, and thus the foundry technologist enters the picture.

As a result of mechanization, the foundry has attained a higher unit production per hour of operation or per man-hour. Close control of sand and metal has come to be highly appreciated by modern foundrymen. Castings with microporosity or macroporosity cannot be accepted for many uses in present times.

The amount of metal in the form of runners and risers remelted increases the cost per pound of castings. Foundrymen are trying to find ways and means for increasing the yield, but it still is in the 45 to 70 per cent bracket. If one could imagine for a moment that it would be possible to make a casting with just the amount of metal required to fill the actual mold, and compensating for liquid shrinkage only, the yield would be nearly 100 per cent. The only losses would be inevitable losses, or so-called process losses, which would be around 5 per cent irrespective of whether the metal is melted in a cupola or an electric furnace. This inevitable loss, in the form of metallic oxides, goes with the slag.

Foundry Technology Advanced

It occurred to the author that a new approach to casting feeding was necessary in order to place foundry production on a more technological basis. Papers published a few years ago in England were along these same lines.[1, 2] At the present time, from the feeding point of view, cast iron castings are at a disadvantage compared to steel castings.

Generally, iron foundries employ gravity pressure for feeding. In the case of large castings, atmospheric pressure is employed by maintaining the riser open to the atmosphere. In small castings, the top of the riser will freeze quickly and the only pressure applied will be gravity pressure. In steel castings, the Williams riser is widely applied. The atmosphere is introduced for a much longer time due to the fact that a core, inserted through the feeder head, will permit atmospheric pressure to act as long as the metal is in liquid form.

However, both gravity and atmospheric pressures cannot solve the two main problems, namely, soundness and yield. In the study of feeding, the writer has come to the conclusion that if a pressure, higher than atmospheric, could be introduced and controlled, both casting soundness and yields would be improved.

NOTE: Presented at the Sixteenth Annual Foundry Practice Conference, American Foundrymen's Association, Birmingham District Chapter, in Birmingham, Feb. 12-14, 1948.

This method incorporates the control of the directional solidification by the temperature gradient. This idea, in the initial stage, calls for a high-caliber man in the foundry, namely, a methods engineer. The proper arrangement for gating and feeding must create the condition for directional solidification. It is generally agreed that the production of sound castings at low cost is the result of many factors of foundry operation. Nevertheless, if only one factor fails, namely, directional solidification, the effects of the other factors are nullified.

Figure 1 shows how pressure, higher than atmospheric, is introduced to the feeding head. The core print is placed in the usual position of the pencil core in the Williams riser, and the container, suspended from this print, holds a compound which will evolve gas when heated to a certain temperature. When molten metal is poured through the down runner, the casting cavity and feeder head become filled with metal. After the time required for a skin of sufficient thickness to form on the head, the heat should have penetrated to the inside of the container, and the gas evolved will build up the pressure and force the liquid steel from the head into the casting.

It can be clearly seen that the function of this so-called "pressure head" relies primarily on the directional control of freezing by the temperature gradient. This being the case, it can be seen that if pressure,

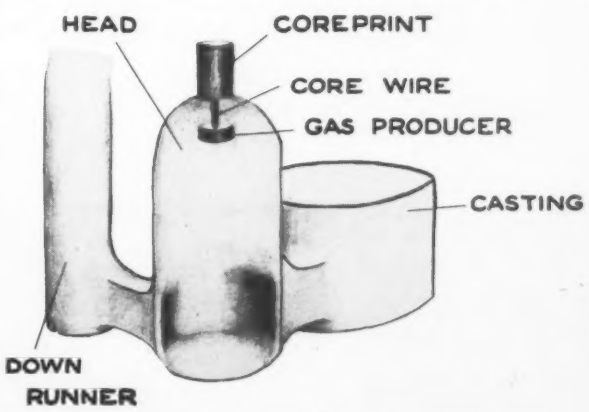


Fig. 1—Method of introducing pressure, greater than atmospheric, into the feeder head.

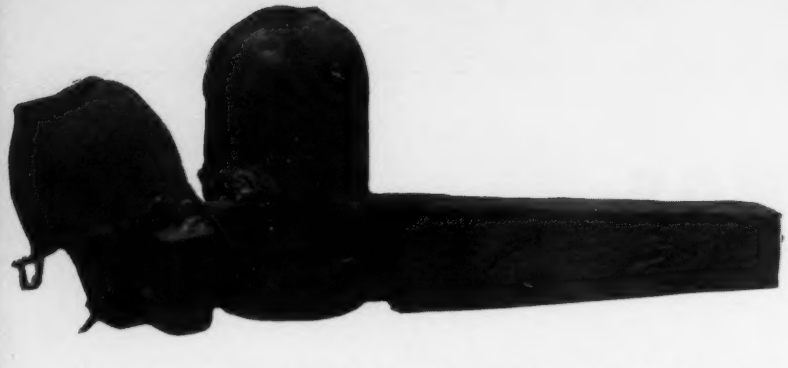


Fig. 2—Rectangular test bar casting designed to check available freezing rate evaluations.

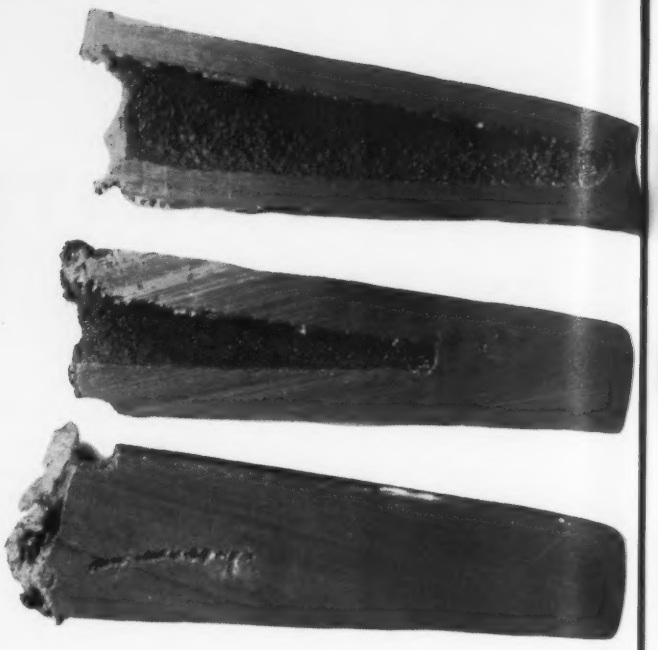


Fig. 3—Castings sectioned to show skin formation

Fig. 4—Sectioned feeder head 7 in. high and 4 in. in diameter shows application of previously determined freezing rate. Note gas-forming compound container.

Fig. 5—Gas pressure cavity and false cavity (top) formed by puncture of feeder after one minute.

Fig. 6—Radiograph showing sizes and shapes of cavities in three feeder heads. Center, head cavity at top continues underneath.

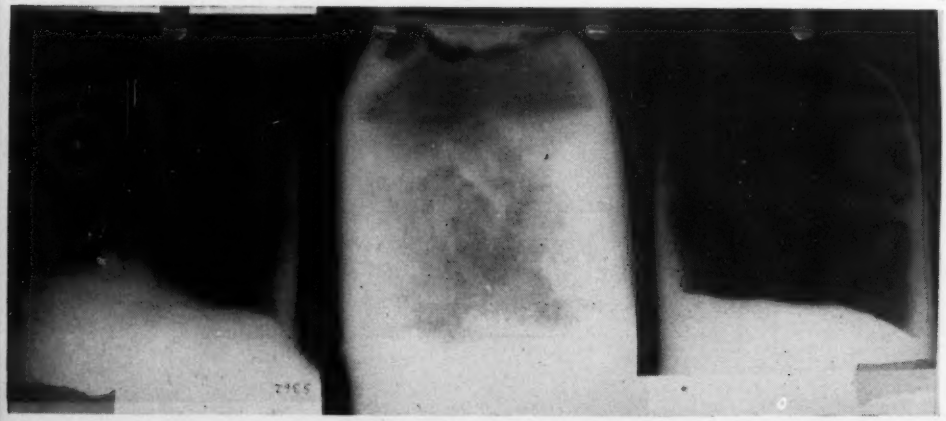
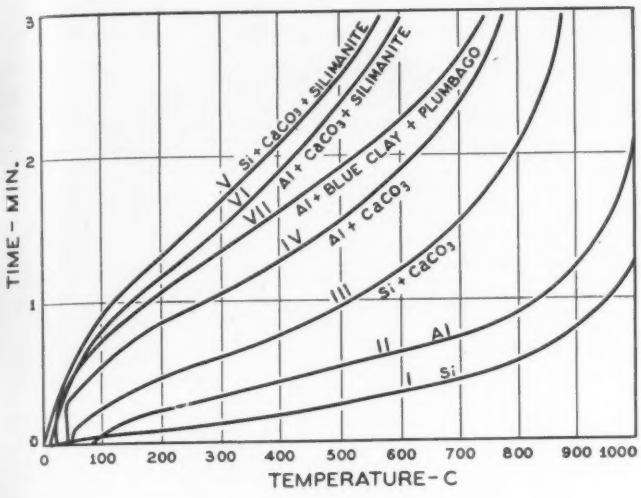


Fig. 7—Feeder head cavities formed (left) by atmospheric pressure and (right) by pressure higher than atmospheric.



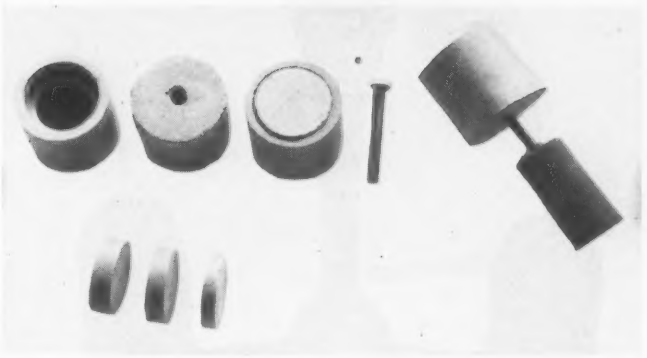


Fig. 7B—Container parts, including lids of different sizes and print for insertion in feeder head.

Fig. 7A (left)—Time and temperature relationships of various compounds used to make containers.

higher than atmospheric, could be satisfactorily introduced, it would be more efficient than pressures used up to this time in feeding castings. It is quite important that a sufficiently thick metallic skin should be formed on the feed head before gas pressure develops, and it is also necessary to find the thickness of the metal which will freeze in a certain time. This means that the time when pressure would be developed should be under control.

The available mathematical evaluation of freezing rate was checked by a series of experiments in order to design a container for a gas-forming compound, material and thickness being considered. To this end, the castings shown in Fig. 2 were designed. The castings are in the form of rectangular test bars, and will serve to illustrate the feeding idea. No attempt will be made to discuss the whole research, which obviously is a subject in itself.

Figure 3 illustrates the manner in which the skin was formed. The pictures represent three different times for drainage of the metal from the casting. From a series of such experiments, the skin thickness as a function of time was assessed, in other words, the freezing rate. In order to maintain definite pressure it was necessary to have a constant freezing rate because viscosity of liquid steel changes rapidly.

Application of a previously assessed freezing rate is shown in Fig. 4 where the feeder head was 7 in. high and 4 in. in diameter. This head was sectioned and it is possible to see the primitive container where the gas compound was enclosed and how the delaying action was applied, which means that the gas started to work after a definite skin thickness was formed on the head. The cavity is one of the flat-bottom type. The enormous size of this cavity leads to the question: "Is that much metal necessary to compensate for the liquid shrinkage?"

In Fig. 5, the cavity formed as a result of feeding the casting in order to compensate for liquid shrinkage and (top) the false cavity are shown. This result was obtained by the puncture of the feeder head after one minute of pouring. As a result, the gas from the feeder head was released and metal in the top started to freeze under atmospheric pressure. When the skin was formed, only gravity pressure was applied for feeding.

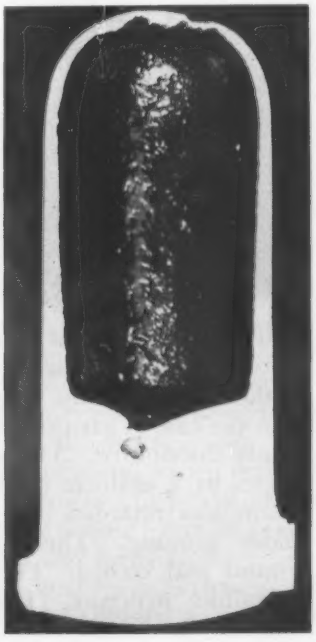
Since this new method of feeding required tremendous experimentation and the sectioning of hundreds of feeder heads, it was necessary to apply a simpler method for the evaluation of the feeder head cavity. Therefore, it was decided to use the x-ray for evaluation of the cavity type and size. In Fig. 6, three x-rayed heads are shown. It is quite clear that the first and third are half empty, and that in the center is empty at the top with a continuation of the cavity underneath.

At this point it would be well to compare the cavity formed in the feeder head under atmospheric pressure to that formed by pressure greater than atmospheric and under the same set of conditions. This comparison is shown in Fig. 7. In the feeder head on the left, the cavity was formed by applying a pencil core, and on the right the cavity was formed by pressure greater than atmospheric.

It is evident that the latter cavity is completely different in shape. It is a surprising thing to see a meniscus in the steel, which means the steel in the feeder head was liquid for a longer time. This was due to the fact that in addition to the gas evolving compound, an exothermic compound was added in order to produce an

Fig. 8—(left below)—Sectioned feeder head showing cavity and compound container without bottom lid.

Fig. 9 (right)—Example of feeder head cavity obtained by gas pressure.



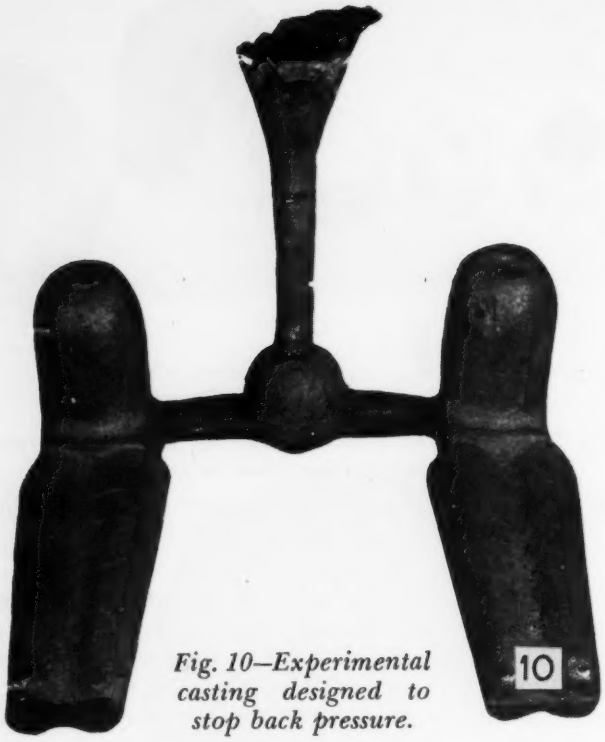
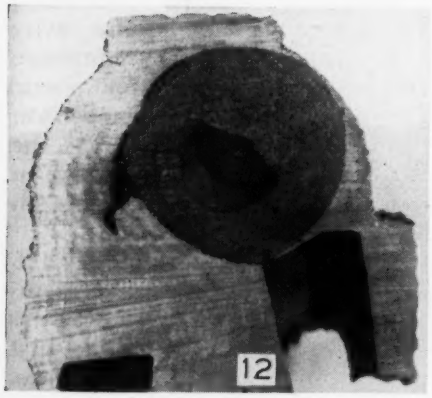
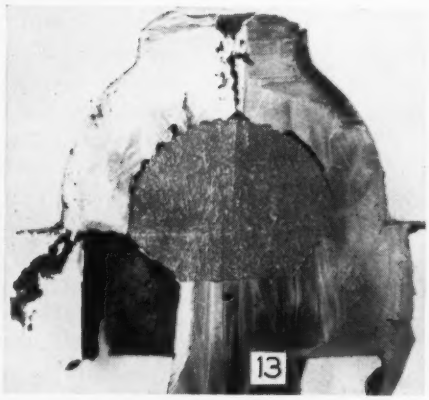
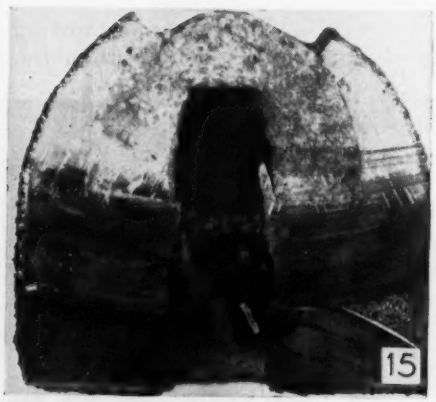


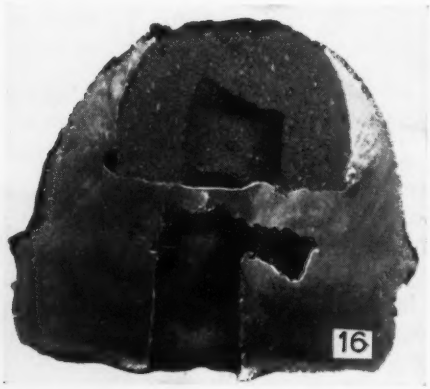
Fig. 10—Experimental casting designed to stop back pressure.

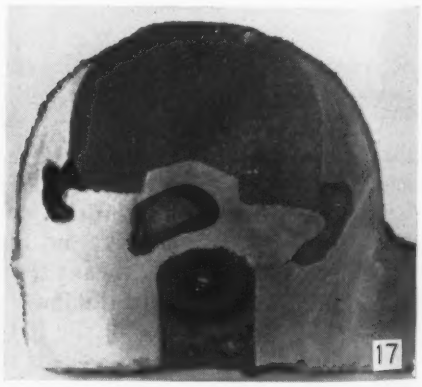
Figs. 11 to 17—These photographs show the various experimental steps in design of a refractory material valve to prevent "blow back" due to gas pressure.











additional amount of heat. It should be mentioned that the thermal capacity, heat conductivity and shape of the mold were the same in both experiments.

In the case of gas pressure, the skin formed is rather evenly distributed. This supports the idea that steel freezes by a uniform thickening of the wall. Solidification was retarded due to the liquid metal being under pressure. These two heads were sectioned, ground and etched. The macro etching revealed a crystalline structure. This crystalline structure is a result of the conditions under which steel freezes. The macro structure on the right (Fig. 7) is much denser, and the transcrystalline structure is not as clearly seen as in the one on the left. The left example shows that freezing was inward from the walls.

In order to delay the action of gas evolution, it was necessary to find a container material of low heat conductivity and of sufficient thickness. The following container materials were used in various proportions: silica flour; alumina; silica flour and calcium carbonate; alumina and calcium carbonate; alumina, blue clay and plumbago; alumina, calcium carbonate and

sillimanite; silica flour, calcium carbonate and sillimanite. In Fig. 7A, the relationships between the time and temperature for these various compositions are shown, and it can be clearly seen that in the case of silica flour, for example, the time required to reach a temperature of 700 C was less than 20 sec.

In the case of silica flour and calcium carbonate, a 90-sec period was needed. It must be pointed out that in these investigations the thicknesses of the containers formed by the various compounds were the same in every instance.

Having ascertained the best compounds for making the gas container, the next problem was to make such a container. Fig. 7B shows a container and a print which was inserted in the feeder head. All parts, including lids of three different sizes, are shown in the picture. For certain groups of castings, the same container was used except that the thickness of the lid varied according to the delaying action required.

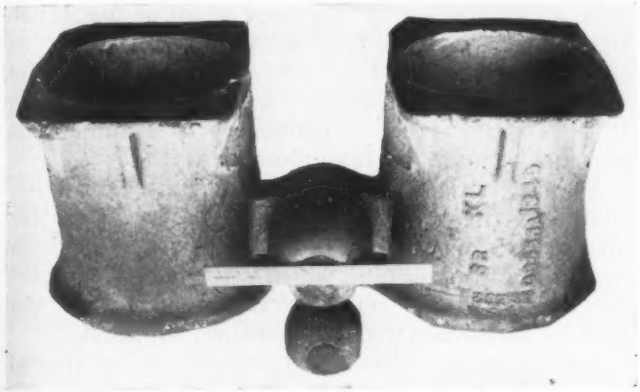


Fig. 18—Two buffer castings poured with only one feeder head. The yield in this case was 80 per cent.

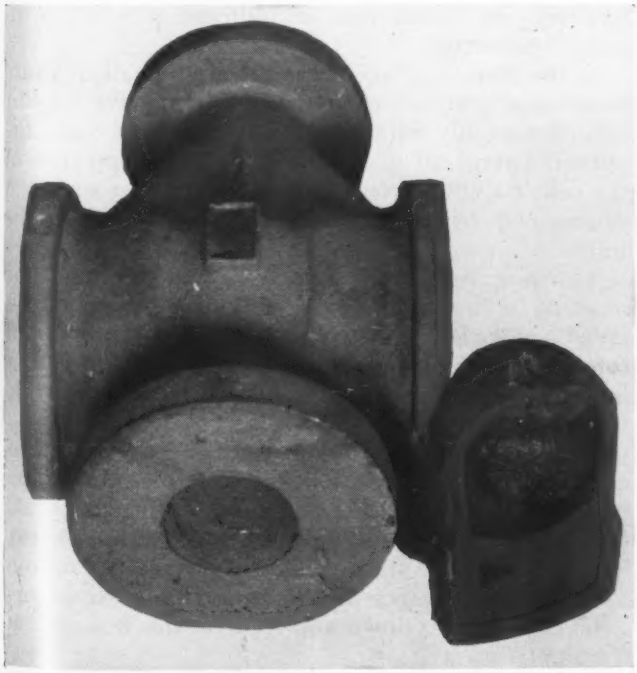
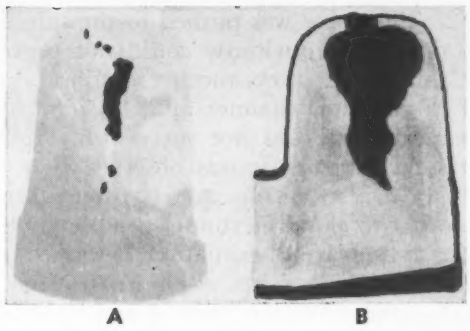


Fig. 19—Valve casting poured with one feeder head instead of the three heads usually employed. Yield was markedly increased and cleaning cost decreased



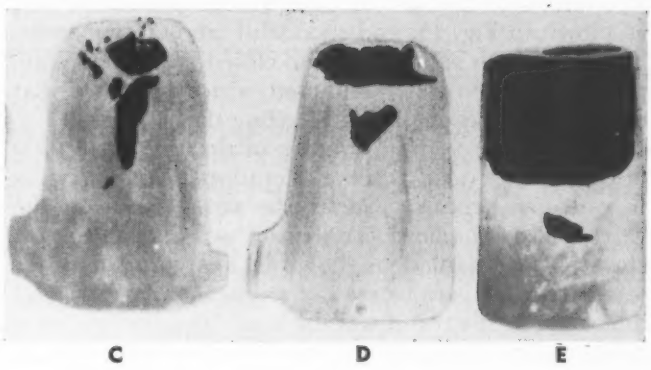


Fig. 20—Various types of cavities formed in feeder heads as a result of (A) gravity; (B)atmospheric pressure; (C) horizonal graphite rod; (D) vertical graphite rod, and (E) pressure higher than atmospheric.

When a certain temperature was reached in the container, gas was evolved which built up the pressure and burst the lid. The pressure, developed and enclosed in the feeder head, acted in all directions. The head metal was under pressure as long as solidification of the casting took place, and metal from the head was taken for compensation of liquid shrinkage.

Figure 8 shows the feeder head and container without the bottom lid, which was ejected under pressure from the container. This investigation confirms that it is possible to control pressure which can be developed after a required time. A fine example of a feeder head cavity obtained by gas pressure is shown in Fig. 9. When the pressure was developed, it naturally acted in all directions. The metal was forced to the casting as well as to the runner, resulting in a defective casting.

It was obvious that it would be necessary to devise means to prevent blowing through the runner. In Fig. 10, the assembly for this particular experiment is shown. From the runner, the metal is poured through the feeder heads to two castings. Underneath the runner is a small head devised to stop back pressure.

In view of the difficulties experienced, it was concluded that some sort of return valve would be necessary. This valve would be immersed in liquid steel and located on the axis of the runner. It was thought that a bowl made from a refractory material would suit the purpose, and Fig. 11 shows the arrangement. Unfortunately, the small amount of metal which entered between the seat of the bowl and the bowl itself solidified quickly and, when the back pressure started to act, the bowl could not move and was ineffective.

The next stage of the experiment was to change the shape of the valve. This helped slightly, as is shown

in Fig. 12. The valve was pushed to the side, leaving one side open, and obviously could not prevent the blow back. Figure 13 shows another modification which behaved in the same manner and, like the first and second experiments, was not successful. From these first three experiments, it was observed that this so-called nonreturn valve has quite a long distance to travel in order to close the runner completely.

In order to improve the situation, it was arranged to locate the valve higher up, as shown in Fig. 14. In spite of this, the valve was twisted and did not close, but was left suspended in the viscous steel. The negative results of this last method were explored further, as shown in Fig. 15, and successful adaptations made. The nonreturn valve lifted and closed the runner completely and the runner collapsed, which indicated that the pressure was utilized for feeding the casting.

Observation of the curvature of the valve and view of the head shows that some alteration should be made in order to produce exactly the same shape on the valve and on the head. When this was done, a perfect closure was obtained, as shown in Fig. 16. This valve was tried with various sizes of runners and heads, and in every case the result was the same, an excellent view being shown in Fig. 17. When the valve worked properly, the runner simply collapsed, and it was unnecessary to use a torch to cut the runner. Following these experiments, castings of various designs and weights were made with success.

Higher Yields—Lower Cleaning Costs

Figure 18 shows two buffers cast on this principle. The yield was 80 per cent on this particular casting. Figure 19 shows another example of a valve which was fed by only one head. Usually, three heads are employed, but in this case one head was sufficient. This arrangement markedly increased the yield and decreased the cost of cleaning about 75 per cent.

During the investigation one interesting aspect was noticed, namely, that steel in the feeder head was in the liquid form much longer than in any other head known. The mostly likely explanation seems to be that the gas contained in the top of the feeder head was thermally insulating the surface of the liquid, preventing it from freezing. Thus the high pressure is in effect for a longer period of time.

Actually, solidification in the head was retarded, creating the best possible conditions for directional solidification. As a result of introducing a pressure higher than atmospheric into a feeder head, a new type of cavity was obtained. Figure 20 shows the various known types of cavities. *A* is a cavity formed when only gravity is employed; *B* is a cavity formed under atmospheric pressure; *C* is the cavity resulting when a graphite rod is horizontally employed; *D* is the result of a graphite rod vertically employed, and *E* shows the sectioned cavity when pressure higher than atmospheric is employed.

As a result of the investigations described, the following conclusions may be drawn:

1. A method of introducing pressure higher than atmospheric into the feeder head was found.

2. Directional solidification and pressure were synchronized and, as a result, the metal was continuously supplied to the casting as long as solidification took place. Any requirements for metal in order to compensate for the liquid shrinkage in the casting were supplied from the active feeder head.

3. A collapsible runner was designed, preventing "blow back" into the runner when the pressure becomes active.

4. Sound castings with a high yield were produced on a principle entirely different from those hitherto known.

References

1. S. T. Jazwinski and S. L. Finch, "A New Method of Feeding Applied to Castings Made in Static Molds," *Foundry Trade Journal,* Nov. 29 and Dec. 6, 1945.

2. S. T. Jazwinski, E. D. Wells, and S. L. Finch, "The Gating and Feeding of Steel Castings," *Proceedings,* Institute of British Foundrymen, vol. 38, p. 155, 1945.

Radioactive Sulphur In Coke Oven Traces Source of Steel Impurities

SOURCE OF SULPHUR IN STEEL is being studied in the largest radioactive tracer experiment ever conducted now under way at the Cleveland plant of the Republic Steel Corp. according to Arthur D. Little, Inc. Believed to be the first such experiment using full scale industrial equipment, the study is the first step in a program designed ultimately to eliminate the presence of undesirable sulphur in steel.

Sulphur can enter steel in any one of several ways—from coke, from ore, limestone, scrap, and from fuel oil. In the finished steel, it has hitherto been almost impossible to determine which raw material supplied the sulphur, but inconclusive tests indicate that coal and its derivatives are the principal suppliers.

There are two important forms of sulphur in coal, pyritic and organic. Since the forms change in the coke oven, there is no chemical method for determining whether the surviving sulphur in the coke came from the original pyritic or organic sulphur.

If one of the forms is tagged with radioactive atoms, however, its travels can be followed precisely with Geiger counters.

In the Republic Steel experiment, a small quantity of artificial pyrites was made from radioactive sulphur and thoroughly mixed with 12 tons of coal; the normal charge to a coke oven. The proportion of the coke's sulphur coming from the pyrites was then determined by measuring the radioactivity of the sulphur.

The proportion has been found to be about the same as in the original coal, indicating that there is no advantage in buying coal with a low pyritic-sulphur content. More tests are being planned to trace sulphur in other materials and chemical combinations involved in the making of steel.

A further use of tracers to control industrial processes is under consideration, for example, radioactive phosphorus added to a Bessemer steel furnace would indicate when the last impurity, usually phosphorus, had been removed from the steel. Automatic controls could then be connected to radioactivity-measuring instruments to turn down and shut off the Bessemer at the right time.

Radioactive tracer research can be used on full-scale equipment, as in the case of the coke oven, eliminating the possibility that the results of laboratory experiments will not hold up in actual full-scale operations.

PATTERN EQUIPMENT

Mechanized Production of Light Castings

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INTRICATE PATTERNS REQUIRED for the production of light castings on molding machines have been made by a method which has proved accurate and economical. It consists, broadly speaking, of taking the impression from the front and back of the original patterns and casting separate plates off these impressions, and having both plates of equal thickness and so located that they make a perfect match. The method has been carried out on three different sizes of plates which vary in thickness, according to their size. In this paper, the method for the 20x26-in. size is described.

A wooden frame (Fig. 1, Part 1) is made to suit the size of molding box, namely, 20x26 in. The frame has two contraction allowances on the length and breadth and two machining allowances on the thickness. Only one machining allowance is provided on the edges. The projections shown in the photograph form fixing points for the subsequent machining operations. This is the master wooden frame. A casting is then made from this pattern and machined on either face to a standard thickness.

Locating pin centers are then marked off accurately on this frame. An error of not more than 0.005 in. is permissible on the diagonals. It is important that these centers should form a perfect rectangle, because the matching of the twin plates to be made depends on this. The centers marked are bored and reamed to ½-in. diameter, and as the molding boxes to be used on the machines have a round hole at one end and an elongated one at the other, this frame is marked *R* and *E* accordingly so that confusion is avoided when the pattern plates have to be matched. The holes referred to may be seen in Fig. 1, Part 2. This is the pattern-molder's master jig.

Making the Master Jigs

Next to be made are eight reels and pins (Fig. 1, Parts 8 and 9), preferably of stainless steel, which is much less affected by molten iron than is ordinary mild steel. These reels have drilled holes reamed to ½-in. diameter, and must provide a sliding fit for the pins.

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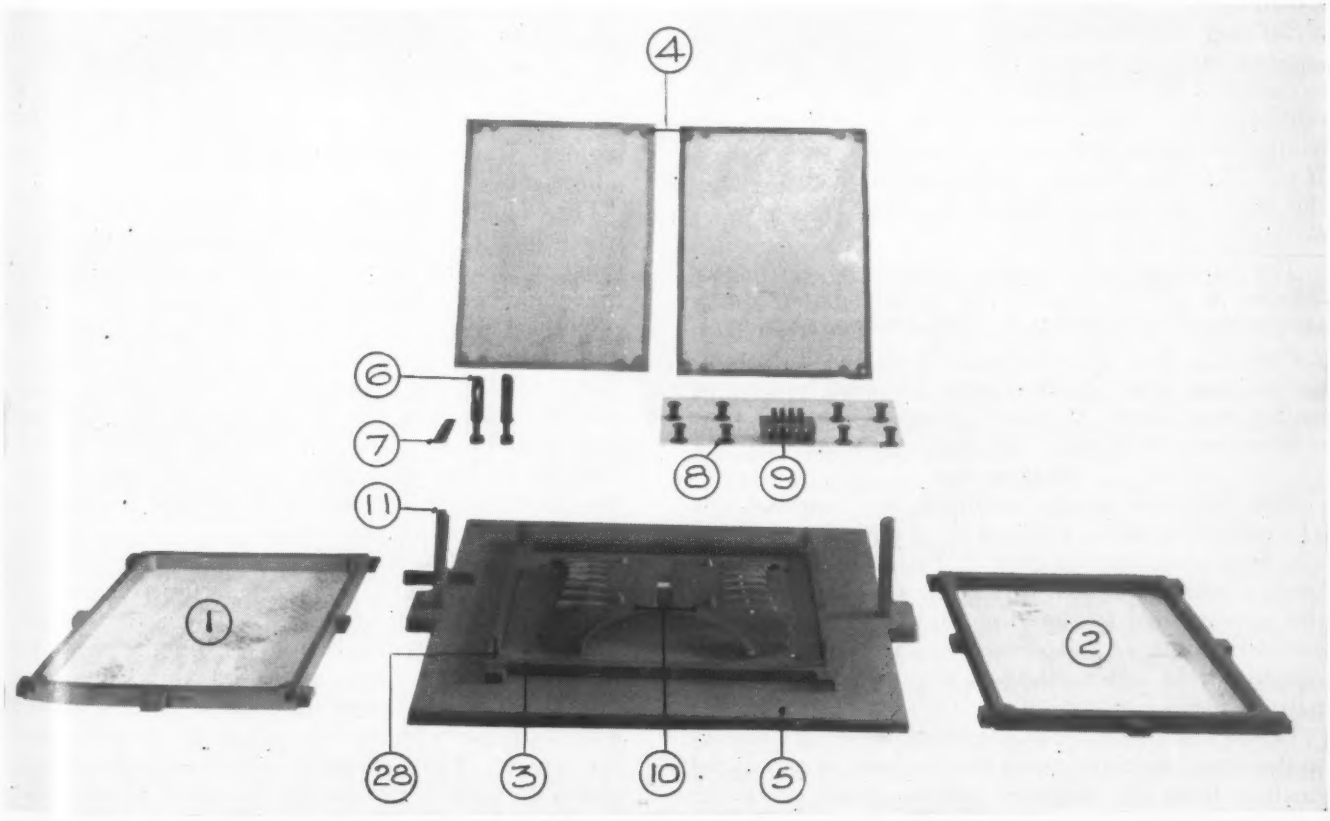
Fig. 1—Pattern parts required by the pattern-molder.



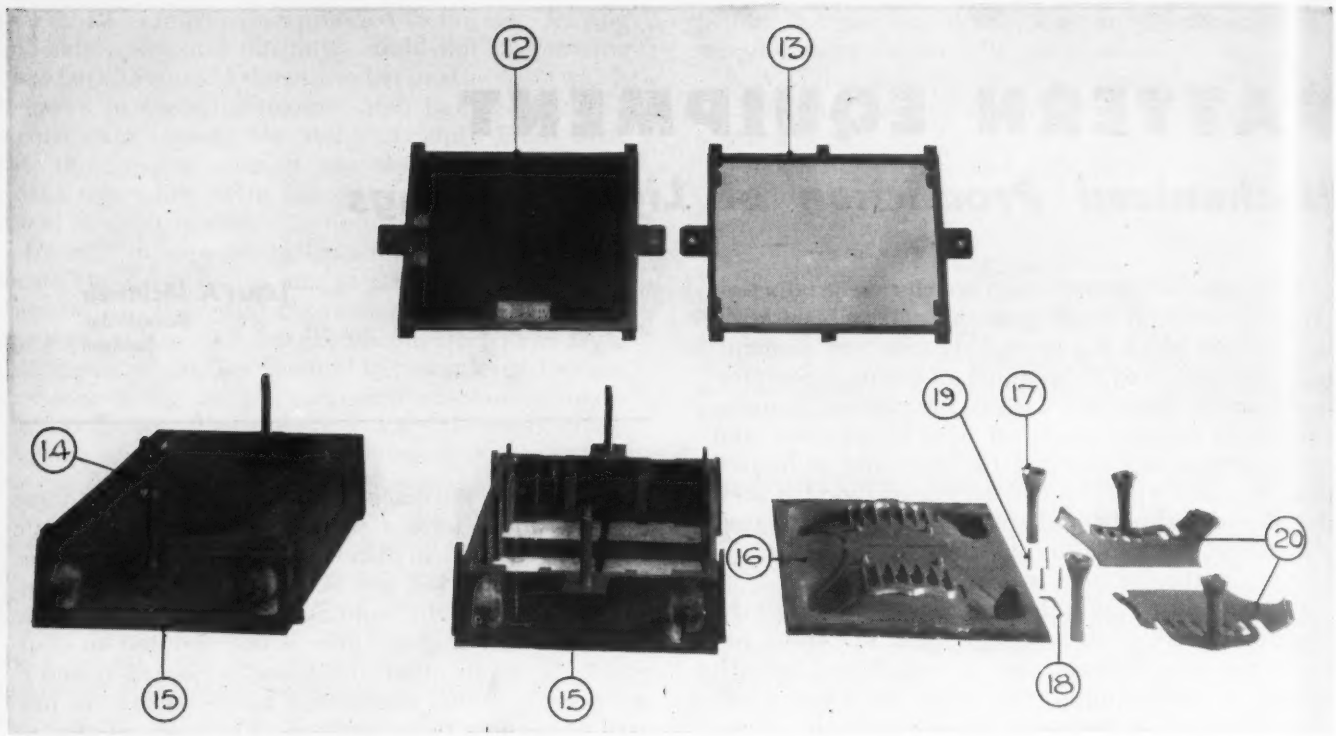


Fig. 2—Equipment needed for fitting-up the plates.

The length of pin required is the length of the reel plus the thickness of the plate to be cast. The reels must be large enough to prevent movement during the molding operations required to make the twin plates. The pattern-molder's jig frame (Fig. 1, Part 2) is next placed on a machined aluminum plate (Fig. 1, Part 5), and then, midway at each end, a snug suitable for the machine molding box pin centers. Into each of the ½-in. reamed holes a locating pin is fitted (Fig. 1, Part 28), and over each pin a reel.

Two solid castings are made from this frame, as shown in Fig. 2, Part 12. The part of the pin which is cast into the thickness of the plates is coated with an aqueous mixture of equal parts of lime and plumbago to facilitate the later removal of the pins and to maintain accuracy. These plates are cast solid to obtain a contraction equal to that of the subsequent twin plates. It will be found that they make a perfect match, one to the other, and one of them is prepared as the fitter's master jig (Fig. 2, Part 12).

The following jigs now have been made: (1) master wooden jig (Fig. 1, Part 1); (2) pattern-molder's master jig (Fig. 1, Part 2); and (3) fitter's master jig (Fig. 2, Part 12). To make provision for the possible breakage of these vital jigs it is advisable that replicas be drilled from them. It should be noted that this time it is unnecessary to make the fitter's jig solid.

Working Jigs

Now the working jigs are made, as illustrated, i.e., (1) pattern-molder's working jig (Fig. 1, Part 3), and (2) fitter's working jig (Fig. 2, Part 13). All jigs are bushed with hardened steel bushes. This completes the jigs required for molding and checking the twin pattern plates. The patternmaker's working jig is machined to the exact thickness required for the twin pattern plates.

Figure 2, Part 15, shows the stools, which are similar to the actual machine stools and are used to make trial castings from the prepared pattern plates when the actual molding machine is not available, e.g., when the pattern plant is being prepared before the actual machines have been supplied by the makers. It is advantageous to prove the plates by hand ramming and make them perfect before putting them into full production.

Accessories Required

Figure 1, Part 5, shows the machined aluminum plate used for setting the pattern plates, and it will be noticed that it is jig drilled to suit the four corner locating pins on the pattern-molder's plate frame. This has the advantage of reducing the molding time on the twin plates if the patterns to be plated are of such design that they can be placed directly in the pattern-molder's frame, thus avoiding the need for ramming a false cope.

Figure 3, Part 21, illustrates four half molding boxes which should be designed to accommodate the whole range of twin plates to be made. It is very important that these boxes be true and interchangeable in every respect. The accessories shown in Fig. 3, Parts 24, 25 and 26, need little explanation, as they are parts commonly used in the making of ordinary pattern plates, namely, bolts, pins, and distance pieces for plate thickness. It should be noted, however, that Part 27 is a loose bush for the box pin centers, made in this way to allow the pins to be easily removed or reversed from cope to drag in the molding operations.

Figure 3, Parts 22 and 23, are parting jacks and washers, respectively. They are accurately made and provide a means for obtaining a perfect parting when the cope is being removed from the drag. The need for this will be appreciated as the box pin centers have only 0.005 in. tolerance. It is impossible to lower or part these boxes by hand owing to the accuracy of the pin centers. The washers are placed on a tenon at the end of the jacks to provide the resistance when applied.

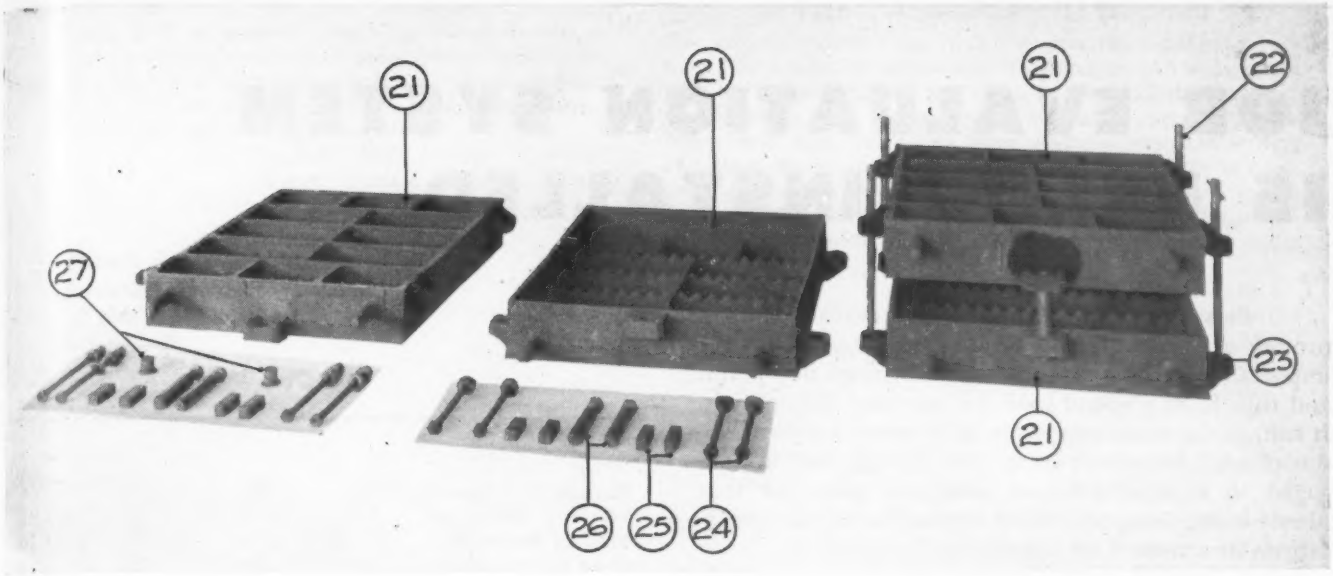


Fig. 3—Four half molding boxes, parts and accessories.

Three sets of box pins are used, namely, "tight pins," "slack pins," and "long pins." The difference in diameter of tight and slack pins is 0.003 in. The tight pins are used when ramming the matching faces of the plates, and the slack pins when ramming the backs or parting the boxes. The long pins are used when making plates with deep cods, since they allow the plates to be raised or lowered as required, to balance the amount of sand in the cope and drag of the finished plates.

In molding the plates, as illustrated in Fig. 2, Parts 14 and 16, the patternmaker's jig frame is first placed on the aluminum plate with the patterns in position, as shown in Fig. 1, Parts 3, 5, 10, 11 and 28. Next, the frame is removed and the reels (Fig. 1, Part 8) are placed in position on the aluminum plate and each located by passing a pin through the reel and the bush in the plate.

One part of the molding box, secured with cotters (Fig. 1, Part 7) is rammed up. After turning it over, the pins are removed from the reels, the cotters are released and the aluminum plate taken off. On this part of the mold a proper parting is then made, and one of the aluminum frames (Fig. 1, Part 4) is put on and located, as before, with pins. The second box part is then fitted, rammed up, and later removed, again by the use of jacks, and placed on a prepared bed. This half forms the cope of the mold which will be cast for the drag twin plate of the particular job.

If the parting of the first half mold is damaged it is repaired and a third part is rammed up and removed, using the reels and pins and jacks in sequence as before. The patterns from the first part mold are then placed into the second, which contains the light aluminum frame. The second aluminum frame (Part 4, Fig. 1) is put over that already in position and located. A mold is rammed up on this, and this too separated by use of the jacks. This cope will eventually form the back of the cope twin plate.

The next operation is to frame up the two molds complete with their reels as if making an ordinary pattern plate. These now are the drags, and the plates may be cast face downward in the mold to insure clean castings. The second and third half-molds are the copes for these drags. The runners are cut in the usual way; a pin, coated with the lime-plumbago mixture, is dropped into each reel; distance pieces are placed on the corners; the boxes are closed (using the jacks), bolted together and cast.

Runners

It may be seen from the illustrations that the runners on the plates for casting the actual job are made of aluminum; they are mounted after the plates have been filed up. This has many advantages. For example, it makes the pattern-molder's job easier, and the runners, if detachable, can be simply adjusted should they be too heavy or the design prove to be wrong when the job is tried out. The original patterns for the runners are made of plaster of paris, which can be cast and cut to the most awkward shapes.

Over 100 pairs of pattern plates for castings of greatly varying shapes and ranging from $\frac{5}{32}$ in. in thickness have been produced by this method, and so far none has failed to match accurately. The stools shown in Fig. 2, Part 15, with slight alterations, make excellent drilling and planing jigs for the engineering shop.

Urge Foundry-wide Participation To Complete Census of Manufacturers

A prompt reply to recently-issued government questionnaires for the Census of Manufacturers will expedite the dissemination of important information to the entire foundry industry.

The questionnaires, mailed to every iron and steel foundry installation in the country, are primarily of value to the foundry industry, not to the government, and are part of the first national survey of manufacturers since 1939. A complete report, expected to be the most complete and valuable ever compiled, will be published sometime during the coming year.

Foundries and allied industries are urged to complete the questionnaires, if they have not already done so, as quickly as possible, and to return them to J. C. Capt, Director, Bureau of Census, Department of Commerce, Washington, D.C.

JOB EVALUATION SYSTEM IS EASILY INSTALLED

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PRIMARILY, the purpose of job evaluation is to provide a precise method for determining the relative importance of the various job classifications in a plant, and thus form a sound basis for pay rate differentials. It can, at the same time, provide a means for comparison of rates between plants, even though they are engaged in making different products, provided that plants being compared have several basic job classifications in common.

Job evaluation can be installed in a plant in a short time without a lot of fuss or fanfare. Once installed, it is a valuable tool for the use of management in making rate adjustments and holding rates in line.

The following plan of job evaluation is designed primarily to be carried through by the foremen and superintendent of a plant, and is thus of educational value since the supervisory force, in rating the various job classifications, become familiar with the different factors involved in rate differentials.

This plan rates each job classification on the basis of ten "job factors," by a point rating system. The range of points will rate 10 points on each job factor for a total of 100 points. This figure is selected merely as a matter of convenience and has no special significance otherwise.

Range of points used for each job factor is a measure of its weight in relation to all the other factors. The more important factors are given more weight by having a greater range between the minimum and maximum points.

The ten job factors, their minimum and maximum points, and the range for each, are listed under "rating instructions." On the factors "Working Conditions" and "Physical Exertion" many classifications in the plant will rate a lower number of points than common labor, which is 10. Therefore, the minimums on these two factors are set at 7 points and 8 points, respectively. The forms and charts used to do the actual rating and the instructions for rating each job factor follow.

Instructions for Rating Job Classifications

Job rating is a precise method of determining why one job classification in the shop should pay more than another. This is done by rating every job classification on the basis of ten job factors. The rating is done on a point system. Each job factor has a range of points by which the rating is done, and the more important factors are given more weight by having a greater range of points.

The ten job factors, with their minimum and maximum points, and the range for each, are:

JOB FACTOR	MINIMUM	MAXIMUM	RANGE
Education	10	20	10
Experience	10	30	20
Skill	10	26	16
Responsibility for Equipment	10	16	6
Responsibility for Product	10	16	6
Possibility of Injuring Others	10	16	6
Working Conditions	7	15	8
Physical Exertion	8	18	10
Mental or Nervous Demand	10	20	10
Accident Hazards	10	18	8

The points for each job factor are set up in such a way that common labor rates 10 points on each for a total of 100 points. On the job factors "Working Conditions" and "Physical Exertion" many jobs in the plant will rate a lower number of points than common labor, which is 10. That is why the minimums on these two factors are set at 7 points and 8 points, respectively.

You will be given a list of the various job classifications in your department which you are to rate. By using the following ten charts, one for each job factor, you will rate each of the classifications with respect to each factor separately. Read the directions on each page carefully, and be sure to consider the jobs in relation to only one job factor at a time. Under each job factor there is a table indicating the number of points to apply when certain conditions are met. You must decide the conditions each job classification in your department are to meet, then take the point value from the table and enter it in the box under the heading "Foreman's Rating" and on the numbered line corresponding to the number of the job classification on your list.

The same classifications will be rated by the superintendent and all ratings will be reviewed again if the two ratings show major differences. The "First Rating" thus arrived at will again be reviewed for each classification in relation to all other classifications in the entire plant. This eliminates the possibility of the jobs in any one department being rated higher or lower than all other departments.

The total rating on each classification is then used as a basis for judging whether or not the base rate is out of line.

The value of the final results depend entirely on how much thought you put into rating the jobs in your department. Remember, you are not rating any particular man, but the job at which he works. Rate the job—not the man.

Job Factor—Education

Date..... Plant ..... Department.....
Use the following table as a guide in rating the jobs in your department listed below. Ask yourself the question, "How much education is required for a worker to do this job satisfactorily?"

POINT RATING	EDUCATION REQUIRED
10	Job requires only that worker be able to follow simple verbal instructions. It is not necessary for him to read or write.
11	Job requires that worker be able to read simple instructions.
12	Job requires that worker be able to convey simple ideas in writing.
13 to 14	Job requires making simple calculations and a knowledge of weights and measures.
15 to 16	Job requires all of the above plus some trade school or equivalent, and ability to read simple blueprints.

17 to 18	Job requires a full high school education or its equivalent. Must understand technical problems of average nature and work with moderately difficult blueprints.
19 to 20	Job requires a full technical training or its equivalent. Must read difficult blueprints, use complicated instruments, and make fine measurements.

	Foreman Rating	Supt. Rating	First Rating	Final Rating
1.	.....	.....	.....	.....
2.	.....	.....	.....	.....
3.	.....	.....	.....	.....
4.	.....	.....	.....	.....
5.	.....	.....	.....	.....
6.	.....	.....	.....	.....
7.	.....	.....	.....	.....
8.	.....	.....	.....	.....
9.	.....	.....	.....	.....
10.	.....	.....	.....	.....
11.	.....	.....	.....	.....
12.	.....	.....	.....	.....
13.	.....	.....	.....	.....
14.	.....	.....	.....	.....
15.	.....	.....	.....	.....
16.	.....	.....	.....	.....
17.	.....	.....	.....	.....
18.	.....	.....	.....	.....
19.	.....	.....	.....	.....
20.	.....	.....	.....	.....

NOTE: This chart serves as an example for the nine charts following, in which the tabulation of job numbers (1-20) has been omitted.

Job Factor—Experience

Use the following table as a guide in rating the jobs in your department listed below. Ask yourself the question, "How much experience is necessary for the average man to learn this job so he can do it with only normal supervision?" Do not consider how long any particular man has been on that job but only how long it would take him to learn it if he were an average man.

Point Rating	Experience Required
10	Job requires two weeks or less.
11	Job requires more than two but less than four weeks.
12	Job requires from one to two months.
13 to 14	Job requires from two to six months.
15 to 16	Job requires from six to twelve months.
17 to 20	Job requires from one to three years.
21 to 24	Job requires from three to six years.
25 to 28	Job requires from six to ten years.
29 to 30	Job requires more than ten years.

Job Factor—Skill

Skill is not the result of education or experience. Skill may be considered the ability to profit by education and experience. A skillful worker is one who knows how to use his head, his hands, and his tools to the best advantage under all conditions. The job of laborer, where no skill at all is needed, is rated at 10 points. The jobs of 1st class patternmaker or machinist will be rated on skill somewhere near the highest value of 26 points. All other jobs will be rated somewhere in between. For guidance in rating the jobs in your department that are listed below, use the following table. Remember that you are rating the job and not the man. Ask yourself the question, "How much skill does this job require?"

Point Rating	Degree of Skill
10	Job requires no skill (laborer).
11 to 13	Job requires little skill (molders' helpers, semi-skilled labor, clerks).
14 to 16	Job requires a fair degree of skill (machine molder, machine operator).
17 to 21	Job requires a high degree of skill (floor molder, all-round welder).
22 to 26	Job requires the highest degree (1st class patternmaker or machinist).

Job Factor—Responsibility for Equipment

The worker, by careless operation or neglect, can cost the company money for repairs or replacement of equipment. To what extent can this happen on each job? If equipment is easily damaged, carelessness in operation may result in a much higher repair or replacement cost than if the same degree of carelessness were applied to equipment less easily damaged. This factor is rated, then, not on the total cost of the equipment handled by the worker, but on the extent of damage in terms of money for repairs or replacement. Use the table below to rate the job under consideration

Point. Rating	Value of Repairs or Repacement to Equipment
10	$ 0.00 to $ 15.00
11	$ 15.01 to $ 35.00
12	$ 35.01 to $ 75.00
13	$ 75.01 to $ 175.00
14	$ 175.01 to $ 350.00
15	$ 350.01 to $ 700.00
16	$ 700.00 up

Job Factor—Responsibility for Product

The product handled by the worker has a definite value in dollars and cents. By carelessless or lack of judgment he can ruin all or part of that product and cost the company money, either to salvage or replace the pieces spoiled. Values shown in the table below are costs to replace or salvage the product a worker might spoil in an average day on the job in question. Consider only the cost of processing up to the point where the piece is spoiled, and not the final sales value, in determining what figure to use in the table. Also, deduct any reclaim value for metal, etc.

Point Rating	Cost of Salvage or Damaged Product
10	$ 0.00 to $ 10.00
11	$ 10.01 to $ 20.00
12	$ 20.01 to $ 40.00
13	$ 40.01 to $ 100.00
14	$ 100.01 to $ 200.00
15	$ 200.01 to $ 400.00
16	$ 400.01 up

Job Factor—Possibility of Injuring Others

How many other worker's safety is involved by the performance of the worker on his job? Is the job such that he must be continually on the alert to prevent injury to someone or is the possibility of injuring anyone remote? Use the table below as a guide in rating the job on the possibility of injuring others.

Point Rating	Degree of Care Required
10	Job requires normal care. Possibility of causing injury to anyone unlikely.
11	Job requires reasonable care to prevent injury to anyone.
12 to 13	Job requires considerable care to prevent injury to others.
14 to 15	Job requires extreme care to prevent injury to others.
16	Job requires highest degree of care. Safety of others depends entirely on the correct action of the worker on the job.

Job Factor—Working Conditions

What are the working conditions encountered on the job? Is it hot? Cold? Wet? Smokey? Dusty? How hot? How wet? How dusty? Also, does the condition merely cause discomfort or does it jeopardize the worker's health, and to what extent? Use the following table as a guide in rating the jobs in your department on the working conditions encountered on each job.

Point Rating	Working Conditions Encountered
7	Good, clean working conditions. No discomfort encountered.
8 to 9	Some dirt and discomfort encountered over short periods.
10	Considerable discomfort encountered over short periods, or some discomfort over longer work periods.

11 to 12	Considerable discomfort encountered over long periods. Some possibility of temporary illness.
13 to 15	Extreme discomfort encountered over long periods. Some possibility of extended illness.

Job Factor—Physical Exertion

How much physical exertion is required on the job? The worker pushing a loaded wheelbarrow all day long would rate higher on this factor than a crane operator who merely pulls or pushes his control levers. Also, the job where an operator must perform the same operation over and over again, even though the exertion is not extreme, would rate higher than one where the operator goes through a variety of motions. Use the following table as a guide in rating the jobs in your department on the physical exertion required on each job.

Point Rating	Physical Exertion Required
8	No physical exertion required.
9	Slight exertion required over short periods.
10	Normal work. Normal exertion required. Occasional moderately heavy lifts.
11 to 12	Continuous exertion required. Monotonous but not strenuous.
13 to 15	Hard work. Exertion continuous and sustained. Monotonous.
16 to 18	Extremely hard work with constant physical strain, or occasional severe strain. Worker must have exceptional physique to do the job.

Job Factor—Mental or Nervous Demand

Is the worker on the job under a nervous strain? Must he keep his attention fixed on the operation he is performing or can he daydream while he does his work? How long are the periods of tension or concentration? How often are they repeated? On this factor the craneman in general will rate high while the laborer will rate low. Use the following table as a guide in rating the jobs in your department on the mental or nervous demand required for each job.

Point Rating	Mental or Nervous Demand Required
10	Job requires minimum mental or nervous demand, or visual attention.
11 to 12	Job requires frequent periods, although not for long, of mental or nervous demand, or visual attention.
13 to 15	Job requires continuous mental or nervous demand, or visual attention.
16 to 18	Job requires concentrated mental or visual attention, with high nervous strain at intermittent periods.
19 to 20	Job requires concentrated and continuous mental or visual attention with continuous high nervous strain.

Job Factor—Accident Hazards

To what possible danger from accidents is the worker exposed on the job? How easily can the accident happen? How badly can he be hurt? Use the following table as a guide in rating the jobs in your department on accident hazards encountered on each job.

Point Rating	Accident Hazards Encountered
10	Few or no accident hazards encountered on the job.
11 to 12	Job involves some possibility of accidents of a minor nature, such as cuts and bruises and burns, but no lost-time accidents.
13 to 14	Job involves some exposure to lost-time accidents such as eye injury, severe burns, hernia, etc.
15 to 16	Job involves some exposure to accidents incapacitating in nature such as loss of limbs or sight, etc.
17 to 18	Job involves considerable exposure to accidents incapacitating in nature as above.

After the ratings are made by the foreman and the superintendent, and any differences resolved on the first "review" discussed in the "Instructions for Rating," the "First Rating" thus arrived at for each job factor is entered in the boxes on the card shown in Fig. 1, a card being used for each job classification in the plant.

The cards are then arranged in the order of their point ratings on the first job factor (Education) which is entered in the box at the extreme left of the card. This puts all jobs requiring the same qualifications on Education adjacent to each other and, as the cards are flipped one at a time by the reviewing parties, any ratings that are out of line are easily picked out and can then be discussed and changed if necessary.

This same procedure is repeated for each of the ten job factors, thus leveling any tendency toward too high or too low ratings in individual departments.

The final ratings for each factor thus obtained are then totaled for each job classification and plotted against base rates for those classifications (Fig. 2).

A straight line is then drawn through the common labor base rate at the 100 point rating, and through the average of all the points plotted. This is done by drawing the line so that the sum of the perpendicular distances from the line to the points above the line is equal to the sum of the perpendicular distances from the line to the points below the line.

Once the curve is established, a value can be determined from it which, when used in a simple calculation, will give the "Evaluated Rate" equivalent to the point rating for each job classification. The evaluated rate for any job classification is that which will fall on the curve, and is the theoretically correct rate for that classification.

The value determined from the curve, since it will vary from plant to plant and from area to area, depending on the rate differential between the common labor rate and other job rates, is called the "Plant Factor."

The plant factor is obtained in the following manner: From the curve (Fig. 2) select any point *P* which lies on the line. Point *P* lies on the 160 point rating line and has a base of $1.46. The base point (common labor) is 100 points with an equivalent base of $1.03. The difference is 60 points which is equivalent to $0.43; the money value for each point above 100 points is $0.43 ÷ 60 points or $0.0072 per point (Plant Factor).

To check this value for the plant factor, assume a job having a point rating of 130 points; then, 30 points

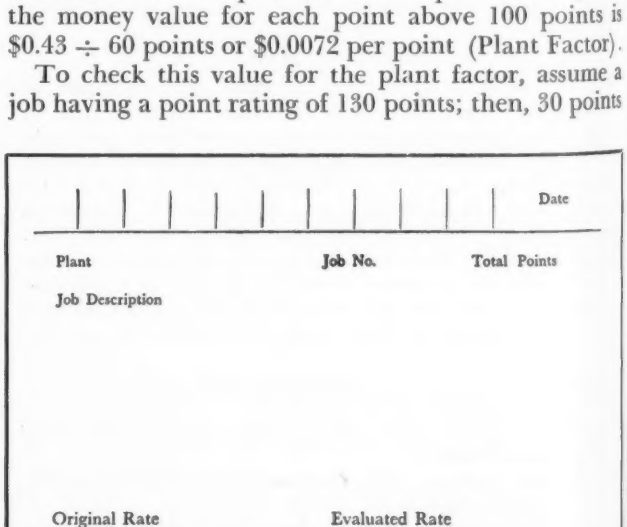

Fig. 1—Job rating card on which job factor point ratings for each job classification are entered.

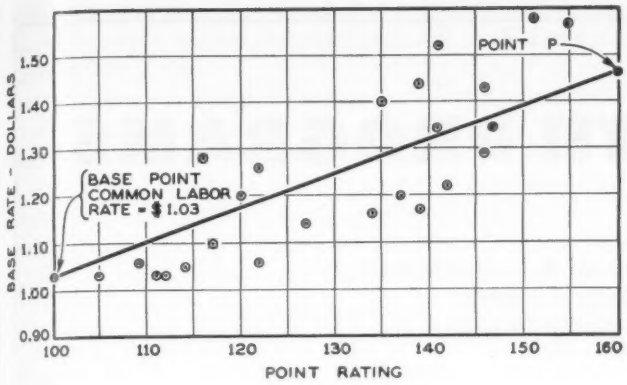

Fig. 2—Curve showing "Evaluated Rate" equivalent to the point rating for each job classification.

@$0.0072 equals $0.216, and since 100 points is equivalent to $1.03 (the common labor base), then 130 points is equal to $1.246 (or $1.25) which is the evaluated rate for the job. This point falls on the curve, and thus checks the value of $0.0072 as the correct plant factor.

After the plant factor has been established and checked, the evaluated rate for each job classification can be calculated as in the foregoing example and a list made showing the rate actually paid compared to the evaluated rate. Such a list can then be used as a guide for making rate adjustments.

Once the actual rating of the various job classifications has been done, they will not change unless there is an actual change in job content on certain classifications. Therefore, it is necessary only to plot the point ratings against the base rates periodically or whenever the number of rate changes is sufficient to warrant a replotting of the rates in order to furnish a revised picture of the rate structure.

If the original rating of the various job classifications is done with care, the value for the plant factor should be somewhere between a minimum of $0.0060 and a maximum of $0.0080. Plant factors below or above these limits would indicate rate differentials which are out of line with the usual experience of the writer with present-day rate structures.

A curve showing wide deviations of the various points from the average line will indicate a poor or haphazard rate structure, and one where the points fall close to the line shows a good rate structure.

How close the actual rates shall be adjusted to the evaluated rates, or how the job shall be accomplished and over how long a period is a matter for individual company policy, and will be dictated to a large extent by prevailing and local conditions. The writer feels that any prevailing rate is reasonable which is within 7½ per cent of either side of the evaluated rate.

Whether the job is done in conjunction with the union or is considered strictly a management prerogative is also a matter for individual company policy. Similarly, the degree to which refinements will be made in carrying out the program, that is, the writing of job descriptions or the setting up of an evaluation committee, must also be a matter of individual preference. The writer has merely tried, in the foregoing pages, to give a plan of job evaluation which has been used with good results, and which can be made to work if used with reasonable care.

Launch County-Wide Scrap Drive To Assist Hard-Pressed Foundries

IN AN EFFORT TO ALLEVIATE the crucial shortage of scrap metal—a shortage that threatens future job security for thousands of local foundry workers—civic organizations of Onondaga County, New York, last month launched their first peacetime scrap drive.

First call on the scrap levies is being given to local foundries, which are hard-pressed for materials to continue high-level operations.

In the city of Syracuse and in the outlying districts of the county, Boy Scout troops, 4-H Clubs, and Future Farmers of America banded together to make house-to-house and farm-to-farm canvasses for scrap metal.

Supporting these active units are the Salvation Army, the American Legion, Syracuse Federation of Women's Clubs, Manufacturers' Association, and many other civic and business groups.

The campaign opened with a highly successful "house-cleaning" of local manufacturing plants, yielding some two million tons of an anticipated six-million-ton goal expected to be reached sometime this month.

Magnesium Alloy Analysis Report

A method for determining the beryllium content of magnesium by spectrographic analysis is described in a recently-issued report of the Office of Technical Services, Department of Commerce.

The method, developed by the Army Air Forces Materials Laboratory, utilizes synthetically-prepared solution samples in a direct-current arc and in high-voltage spark sources.

Full details of the method and procedures, including preparation of standards and electrodes and pertinent tables and graphs are contained in Report PB-85768—*A Method of Spectrographic Analysis for Beryllium in Magnesium Alloys.* (Seven pages, Price $1).

Rare Volume Presented to Library

"Analyses of Pig Iron—Volume II," published in 1902 by Seymour R. Church, San Francisco pig iron jobber, was presented recently to the A.F.A. Library by Frederick W. Bauer of Bauer-Wilson and Bateman, Chicago.

Bound in moroccan leather and profusely illustrated, the 197-page volume is one of the few of its kind in existence. Issued prior to establishment of U. S. Bureau of Standards Codes, the volume features articles by A.F.A. members on standardization of pig iron samples and cites the early efforts of A.F.A. to establish more uniform methods of making analyses by means of standard samples.

Reprint Popular Timestudy Paper

"Establishment and Use of Standard Data—Time-study Techniques" by Milton E. Annich, American Brake Shoe Co., a paper which was received with great interest at the Detroit Convention last year is available as a separate publication. It also appears in the TRANSACTIONS OF A.F.A., vol 55.

Association members desiring a copy of this reprint at no cost should mail their request to S. C. Massari, Technical Director, American Foundrymen's Association, 222 W. Adams St., Chicago 6, Ill.

INDUSTRIAL HEALTH PROGRAMS IN ACTION

Harold A. Vonachen, M.D.
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TODAY, the prospective employee sees industrial medicine not only as a profession that seeks to cure, but a profession that seeks to prevent. Its influence extends into the community from which an industry draws its people . The company with which the author is associated has every reason to believe that its medical program has materially influenced the health standards of the community. This is not looked upon by the company as a philanthropy; above all, it is not paternalistic or done for its advertising effect or as a sop to the employees. Rather, it is an important function of management.

The potentialities of an industrial health program cannot be interpreted in terms of dollars and cents because it frequently results in confusion. Who can calculate the value to the company in the reduction of lost time by curbing sickness or epidemics? Furthermore, it would be most difficult to appraise the assets to the company, or the economic savings accruing to the employees, as a result of adequate physical examinations. Most of the benefits, it is felt, are bound to be unmeasurable. Others are slowly yielding to some sort of evaluation. Such has been the author's experience.

Program Objective

Fundamentally, the philosophy of an industrial health program is an attempt to increase the sum total of human comfort and well-being, which is the ultimate objective of all human endeavor, whether this be business, politics, religion or science. Industrial health program personnel are trying to prevent things which will destroy that state of comfort and well-being. They are trustees of human health. Their first responsibility is to the sick or injured employee. The fact that they are paid by industry does not release them from this obligation.

Actually, the program begins before the employee starts to work. The first measure employed is to make sure that he is given a job at which he can work willingly and well. Through an interview by the personnel division, his possibilities as a suitable applicant are appraised.

Should he be qualified in certain skills it is not enough that the company rely on hiring him for his ability as a swing grinder; it should be taken into account that the company is also hiring his eyes, lungs, heart, ears, behavior, attitude, likes and dislikes, fears, etc., before any final decision is made. The routine in this plant is more than a physical and laboratory examination. It takes into consideration the ability of the individual to undertake the affairs of life in a manner which will not interfere with his future usefulness.

1. Psychological Testing for Selection and Placement—This consists of an intelligence test, a mechanical aptitude test, and two tests for emotionable stability. Applicants are studied from the standpoint of capabilities and liabilities and are placed accordingly. A psychograph (personality) profile is prepared as part of the medical record and the data used in assigning the individual to the job.

Records of those employees tested previously were reviewed to determine if the results obtained could have predicted the employee's subsequent job performance as rated by the foreman. In 72 per cent of the cases, the tests agreed with the foremen's subsequent appraisal. In 28 per cent, there was disagreement. In other words, with these test scores obtained prior to job assignment, it was possible to predict with fair accuracy which employees were likely to do well and which were likely to do poorly on a starting job.

2. Preplacement Examinations—These examinations are not a screen by which only the best applicants are selected. The objective is safe, productive employment for the individual, and at the same time protection for the existing working force. During 1946, 15,400 applicants were examined.

Previously, rejections had varied from 5 to 8 per cent. Today, this has dropped to 3 to 5 per cent because of the interest and action taken relative to better and safer placement of the handicapped. New attitudes and improved personnel facilities have made it possible to give employment to more of these people. About 95 per cent of the rejections are for uncorrectible eye defects, hypertensions, heart disease which indicates that exertion would cause undesirable end-results, active tuberculosis, diabetes, contagious diseases, spastics, advanced orthopedic defects, persistent dermatitis and varicosities.

3. Periodic and Request Examinations—Averaging from 500 to 700 annually, these examinations are in the interest of health conservation and are performed at intervals, the need being determined by the hazards of the work. By comparison with previous examinations, they are of great value in uncovering conditions of which the employee is not aware. In the case of certain defects, a reassignment may be recommended.

4. Transfer Examinations—Under certain conditions, these examinations are given to insure that a change of job in the course of employment will not

Excerpts from a report presented at the 12th annual meeting, Industrial Hygiene Foundation, at Mellon Institute, Pittsburgh, Nov. 20, 1947. Reprinted from *Industrial Hygiene Digest*, Nov. 1947, vol. 11, no. 11.

result in misplacement which the preplacement examination sought to avoid. About 1,200 such cases are cleared annually.

5. Return to Work Examinations—Averaging 5,000 yearly, these examinations are given employees absent for more than 7 calendar days because of illness, or more than 14 calendar days for personal reasons. They are for the protection of employees who often return too soon after sickness or injury, or who wish to resume work for which they have become unfitted.

Special Services

6. Key Examinations—Annual examinations are performed on 143 executives. There are certain factors which constitute a particular danger to this group. Their hours, first of all, are undefined. Their work is not measured by time served, but by goals achieved. The tension of the job becomes the tension of much of their entire day, with its accompanying physical and mental manifestations. A recent survey covering a 5-year span shows gratifying results in blood pressure stability and weight maintenance. Repeated counseling and early symptom consultation has been popular, and its intrinsic value conclusively demonstrated by their aging gracefully.

7. First Aid—Services are offered through a main station and six outlying stations strategically located, with a seventh station opened about the first of the year. During 1946, 90,000 cases of occupational origin were treated. Insistance on immediate reporting and care as well as follow-up visits, coupled with modern methods of diagnosis and therapy, has prevented much suffering, hastened convalescence and made possible an earlier return of employees to their jobs. It has reduced by 25 per cent the actual moneys paid out as final settlements for amputations, loss of use of members, and other related conditions.

8. Physiotherapy—This treatment is offered by a trained, accredited physiotherapist, and is under the supervision of the staff physicians. Here use is made of varied physical agents in the treatment of injuries. The convalescent period is decidedly reduced and the employee is able to return to his job in good condition. Approximately 6,000 treatments are furnished annually to injured employees.

9. Medical Laboratory Services—Accredited technicians in the laboratory afford many diagnostic aids, including urine analyses, and blood serology for all applicants. Over a 10-year period, 95,000 Kahn tests have been performed, revealing 1,400 positives which have had the necessary verification tests. In the absence of contagion these individuals are employed if they agree to report regularly to their family physician or a clinic, and furnish the medical service with regular certificates of attendance.

Blood Bank Maintained

This case-finding project is on a truly confidential basis. In cooperation with all the local hospitals, a blood bank is maintained for company employees and their families. Blood typing is performed in the laboratory and a card index system of donors kept on file. Transportation to a hospital is furnished by the company in case of a blood emergency. The laboratory has, since 1936, been approved by the State Health Department. This laboratory makes weekly tests of all wells supplying drinking water for the plant. In addition, it conducts periodic analyses of milk and ice cream furnished the cafeteria by a local dairy.

10. X-Ray—This service makes use of a 500-milliampere x-ray with fluoroscope and a 4x10 photoroentgen unit. Routine chest films on all new applicants, with periodic retakes on others, assists in proper placement and, where indicated, helps employees avoid dusty environments and other areas considered hostile to the pulmonary tract. It assists in uncovering lung pathology such as tuberculosis, and also other lesions of the respiratory tract. Many seek retakes even in the face of an asymptomatic period.

In 1944, cooperating with the official and local tuberculosis agencies, a chest x-ray survey was made in which 83 per cent of the available employees in the plant participated. In 1947, this survey was repeated and 97 per cent of the available employees participated. In the 1944 survey, 22 active cases were uncovered and institutionalized. In the 1947 survey, only six active cases were found. There has not been a proven case of silicosis on our books in the past 10 years, in spite of the three cases filed.

11. Eye Testing—Sight screening is required for all new applicants. This appraises their visual habits for near and distant vision. Those not meeting the standards are withheld from employment until proper prescription glasses are obtained, depending upon the job and age of the individual. A part-time optometrist working under the supervision of a consulting ophthalmologist supervises the program.

Comprehensive Sight Check

This affords better and safer placement, and many persons are grateful when informed of the defects uncovered of which they had no previous knowledge. Since job safety and good sight go hand in hand, the service is now checking those employees who have not been previously screened. In two months, 1,893 employees were checked, of whom 453 or 25 per cent were found to need attention. Of these, 109 or 24 per cent have asked for and received interviews. Corrected glasses were obtained by 122 or 27 per cent.

12. Industrial Hygiene Laboratory with Trained Personnel—This service insures adequate health protection through routine and periodic appraisal and evaluations of workroom environments for atmospheric contaminants and related exposures; and also serves as a constant check upon the efficiency of the methods introduced to prevent the occurrence of occupational diseases. An advisory committee from several operating departments cooperates with the hygienist to provide for its successful operation.

Special studies and regular inventories of unsatisfactory occupational risks have proved effective in safeguarding the working force. This has resulted in a reduction of several thousand dollars in payments for dermatitis cases over a 2-year period.

13. Nutrition—Very much to the front in physical fitness is the eating of proper foods. Daily menus prepared two weeks in advance are reviewed by the medical division. For the obese personnel in the supervisory group, a "Fat Man's Club" is in operation. Membership is not terminated until the optimum scheduled weight is attained.

14. Licensing Vehicle Operators—Since physical defects may have a direct bearing on accident occurrence,

crane operators, power truckers, tractor drivers and others, after completing a series of tests given by the safety division, have those reports as well as their medical records checked for final approval before assignment to the particular job.

15. Rehabilitation—provides economic restoration to employees who have received occupational injuries. Some of our 6,000 World War II veterans have also required medical evaluation and appraisal for selective placement. Other handicaps selectively placed have come to us direct from civilian life. Approximately 1,800 handicapped persons with varied physical impairments are now employed. One department alone has about 150 one-eyed people. Once they are selectively placed and doing the job, the term handicap becomes obsolete. Our experience with the handicapped has been quite encouraging.

16. New Investigations—A recent project in action concerns the vaso-spastic or "dead finger" syndrome among foundry chippers using pneumatic tools. Since the manufacturers of these tools felt that redesign of the pneumatic hammer to prevent this vascular disorder was impossible, the resources of the company's medical division, research department, and foundry supervision were combined in an effort to conquer the problem. From recent reports, it appears that the problem of this occupational disorder may be solved.

Conclusion

Some foundrymen feel that the foregoing outline is "big plant stuff." Then it may as well be argued that production efficiency itself is strictly a big-plant matter.

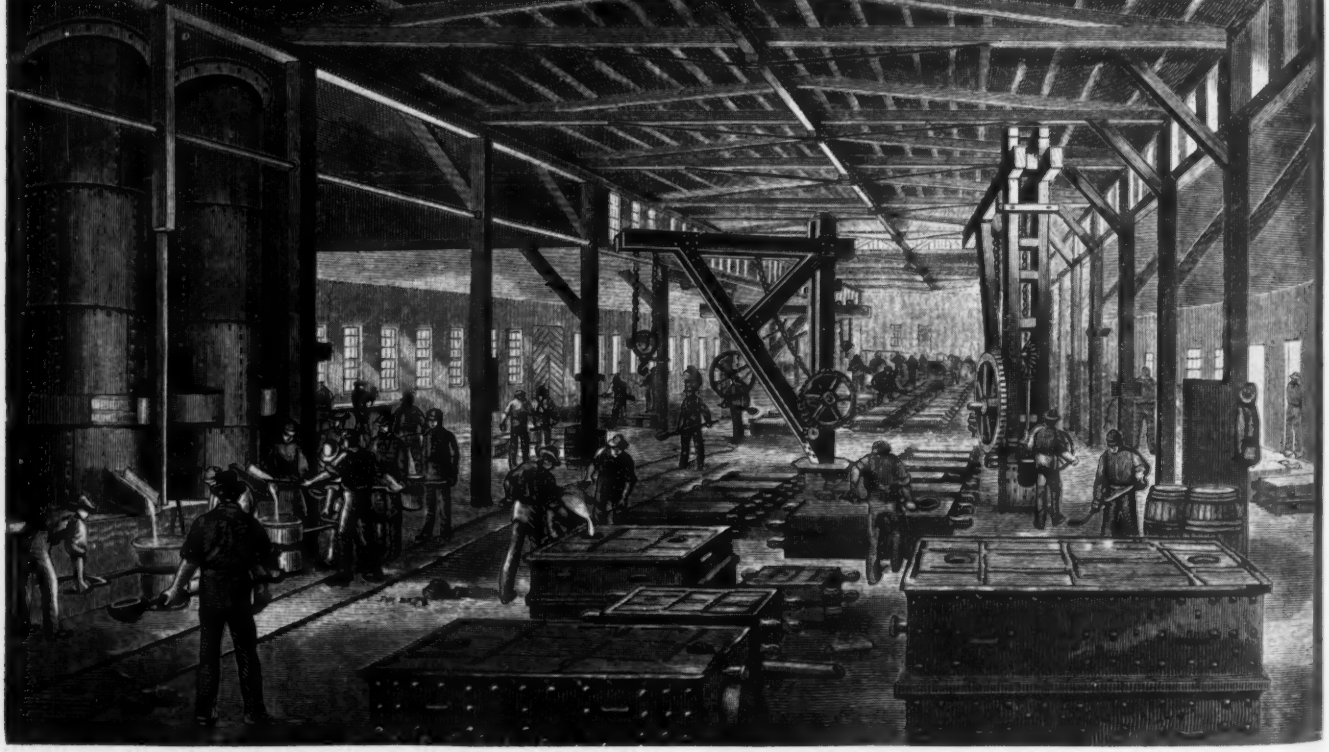
Since opinion polls are commonly used as basis of how people think and what they want, it may be well to conclude this outline by enumerating what the company's foremen, supervisors, industrial and labor relations personnel and others think about the industrial health program.

Benefits to Employer

Avoids entrance of potential human liability.
Assures healthy working force.
Promotes safety.
Improves employee-employer relations.
Protects against public criticism.
Affords better job placement.
Promotes community relations.
Improves the company's trade position.

Benefits to Employee

Affords proper job placement.
Increases period of gainful productive employment.
Insures family and dependents a more stable economic security.
Protects fellow employees.
Assists in up-grading employee safely.
Aids in adjustment of his work.
Provides him with information about his own physical condition.
Learns to rely on approved medical care.
Learns the importance of prompt medical care.
Assists in obtaining benefits due him.
Prevents development of disabling disease.



Mechanization of foundries has come a long way since this woodcut of the main foundry, Edward P. Allis & Co., was made in the late 1800's. Starting its second century, Allis-Chalmers Mfg. Co., has one of the largest gray iron foundries and most diversified brass foundries in the country. The steam crane is typical of the foundry equipment of last century. Cupolas of one-piece construction with drop bottom, left, were first used about 1860 according to the newest A.F.A. publication, DEVELOPMENT OF THE CASTING INDUSTRY.

UNUSUAL STRUCTURES OBSERVED IN GRAY CAST IRONS OF HIGH SULPHUR CONTENT

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IN A COMMERCIAL GRAY IRON FOUNDRY, cast iron of high sulphur content was produced by accident on two occasions. Subsequent examination of samples of the irons revealed unusual microstructures and reaction to heat treatment, and it is the object of this paper to describe these structures.

High Sulphur Content Cast Iron

In the foundry in question the cupola normally was operated at a melting rate of about 8 tons per hr, producing iron of the composition given in No. 1, Table 1. One day, in the early afternoon, the iron from the cupola without warning became dull in color, and fluidity slowly decreased. Small castings, when broken, showed a white fracture, and chemical analysis of the iron gave the results shown in No. 2, Table 1.

The source of the high sulphur content shown was found to be lumps of weathered iron sulphide (pyrite), which had accompanied a shipment of scrap iron and which had the appearance and weight of broken lumps of heavy iron scrap. The material was found to contain 25 per cent of sulphur, and, of course, only a few small pieces in a cupola charge were necessary to introduce a considerable amount of sulphur.

Two days later, the same change in color of the molten iron was noted at the cupola spout, and immediate investigation showed that a few pieces of the same pyritic material had been charged into the cupola by an overzealous charge hand. The chemical analysis of the resulting iron was as given in No. 3, Table 1.

It is noted in Table 1 that the manganese content of the iron had decreased, probably by flotation in the form of manganese sulphide into the cupola slag, as the sulphur content increased. This effect has been noted many times in high sulphur irons.

It is also noted in Table 1 that important decreases in carbon content of the iron had accompanied higher sulphur contents. This alone would produce a serious decrease in fluidity, and a probable increase in depth

TABLE 1—CHEMICAL ANALYSES OF CAST IRONS

Components	No. 1	No. 2	No. 3
Total Carbon, per cent	3.50	3.13	3.24
Silicon, per cent	2.50	2.41	2.49
Manganese, per cent	0.60	0.37	0.45
Sulphur, per cent	0.12	0.41	0.27
Phosphorus, per cent	0.45	0.45	—

Fig. 1—Dendritic arrangement of graphite in gray iron portion. Etched in 2 per cent nital. ×100.

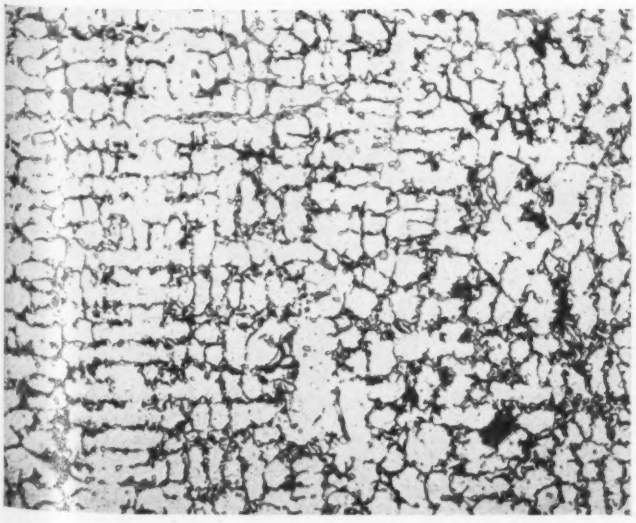
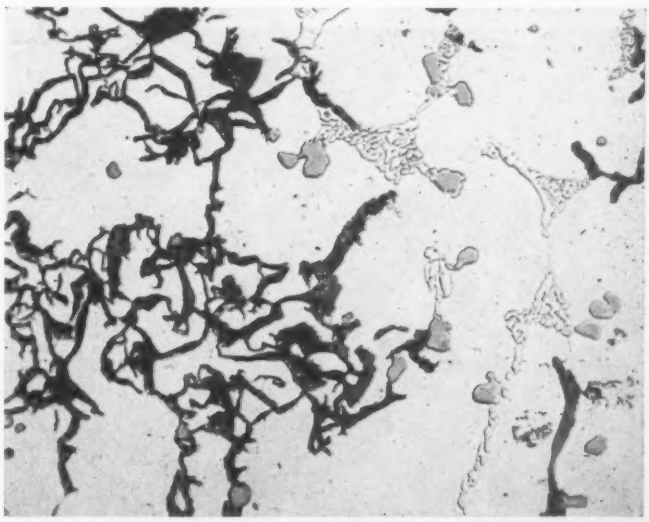


Fig. 2—Note coarse structure of phosphide eutectic in gray iron portion. Etched in 2 per cent nital. ×500.



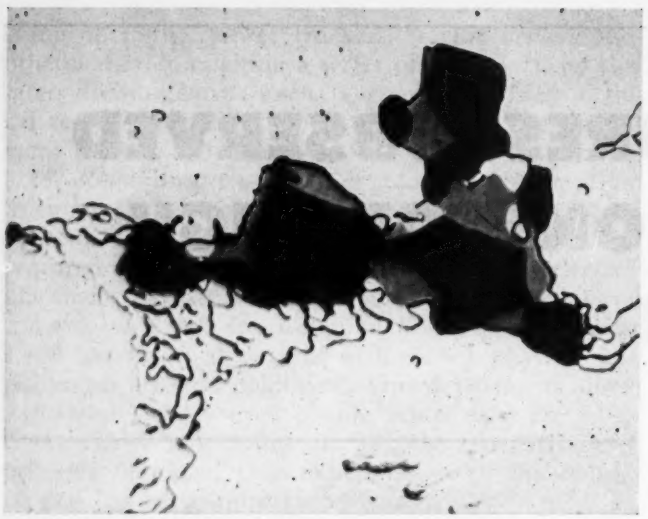


Fig. 3—Duplex MnS-FeS inclusions and phosphide eutectic in gray iron. Etched in 2 per cent nital. ×1500.

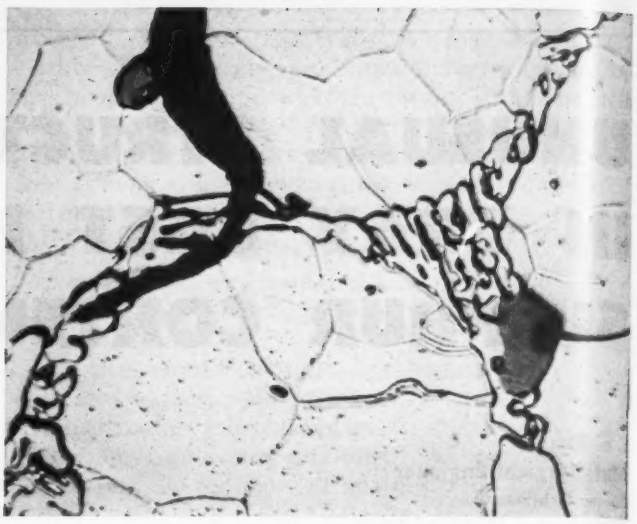


Fig. 4—Duplex MnS-FeS inclusion, phosphide eutectic, graphite and ferrite. Etched in nital. ×1500.

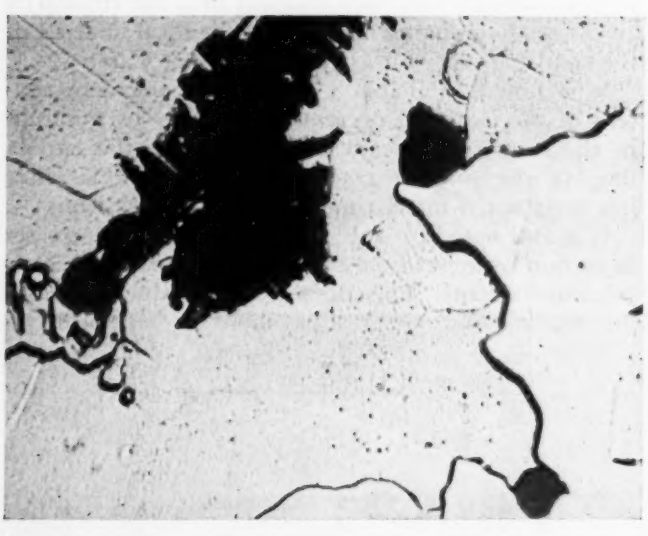


Fig. 5—Carbide, MnS, graphite and ferrite structures in white iron rim. Etched in 2 per cent nital. ×1500.

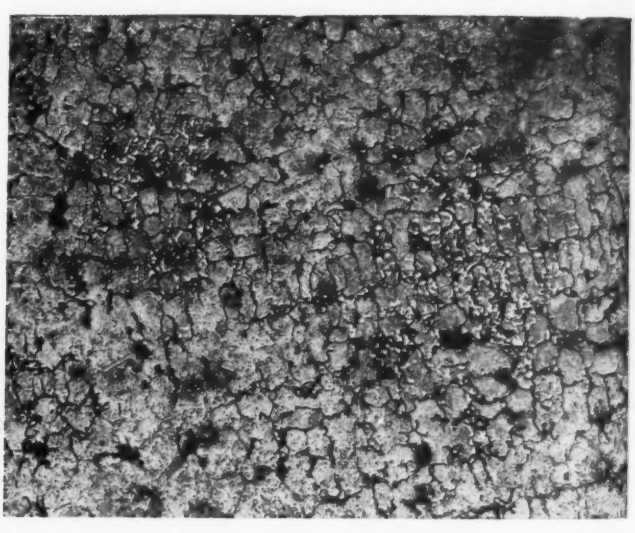
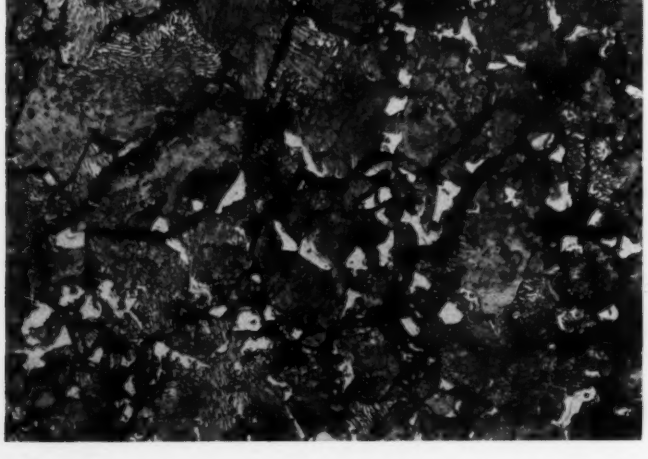


Fig. 6—Structure shows pearlite, graphite and ferrite, after heat treatment. Etched in 2 per cent nital. ×100.

Fig. 7—Pearlite, graphite and ferrite structure after heat treatment. Etched in 2 per cent nital. ×500.

Fig. 8—Microstructure of gray portion shows pearlite, graphite and MnS. Etched in 2 per cent nital. ×1500.



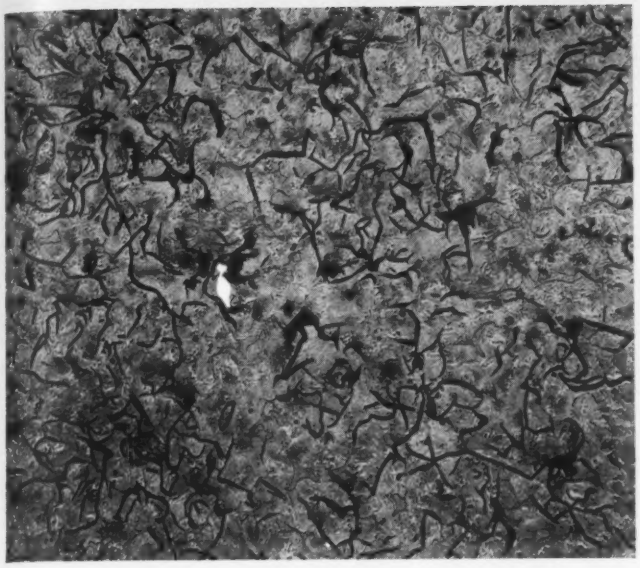


Fig. 9—Sample No. 3 as cast shows normal pearlite structure and graphite. Etched in 2 per cent nital. ×100.

Fig. 10 right—Pearlite, graphite, phosphide eutectic, MnS structure. Etched in 2 per cent nital. ×1500.

of chill. The silicon content of the iron had been apparently decreased only slightly by the high sulphur content, and the phosphorus content, to all appearances, was unaffected.

Description of Samples

A sample was broken from a casting of No. 2 iron, one inch by three-quarters inch in cross section as cast. The fracture was white around the outside to a depth of 1/8 to 3/16 in., leaving a gray center. Samples for metallographic work were cut from this piece with a wet abrasive cut-off saw.

Number 3 iron sample was obtained from a one inch square transverse bar. Although the fracture of the bar was completely gray, with no trace of chill, it was almost impossible to cut with a hacksaw. The indentation hardness was found to be Rockwell "B" 98, which provides no explanation of the resistance to cutting. The mechanical properties of the bar, broken on 12-in. centers, were 2,700 lb breaking strength, with 0.181 in. maximum deflection.

Metallography

Microstructures found in the sample of No. 2 iron as cast, as previously described, are shown in Figs. 1 to 5, inclusive. Figures 1 to 4 show the gray iron portion, and Fig. 5 the white iron rim.

It was notable throughout this sample that no trace of pearlite was present, either in the gray or white portions of the sample. The matrix material is identified as ferrite, rather than as austenite, since the sample as cast, and as shown previously (Table 1 and Figs. 1 to 5, inclusive), was as strongly attracted to a magnet as was gray cast iron of normal composition.

Experimental Heat Treatment

A portion of the sample of No. 2 iron as cast was heated in a muffle furnace to 1750 F, held at that temperature for 2 hr, and then removed from the furnace and allowed to cool in air. The object of this procedure was to test the thermal stability of the cementite in the white iron rim. The microstructure of the originally gray portion of the sample after this heat treatment is shown in Figs. 6 to 8, inclusive. The structure of the originally white portion was changed by the annealing treatment to one similar to that shown in Figs. 6 to 8, except that the graphite was roughly nodular in form.

After the annealing treatment the general microstructure of the iron is seen to be a normal pearlite, with traces of ferrite. A notable feature of the annealed sample was that the duplex sulphides had disappeared completely, only dove-gray sulphide inclusions being found in the heat treated sample.

The microstructure of No. 3 sample as cast is seen to be that of normal pearlitic gray iron (Figs. 9 and 10), with an abnormally large content of manganese sulphide inclusions. In Fig. 10 the phosphide eutectic is seen to be of normal type. No evidence of the cause of the difficulty of cutting with a saw, mentioned previously, is found in the microstructure.

Conclusions

From the chemical analyses given in Table 1, it appears that the introduction of high sulphur content in a cupola charge causes a decrease in the carbon content of the resulting cast iron, as well as the expected decrease in manganese content due to flotation of manganese sulphide.

In the iron containing 0.41 per cent sulphur (No. 2 sample), the phenomenon of solidifying free of pearlite and of recovering the property of pearlite formation after a short high temperature annealing treatment is without explanation at present.

The cast iron containing 0.27 per cent sulphur (No. 3 sample), apparently is of normal microstructure, and no explanation of its resistance to cutting is evident.

INGOT METAL vs. VIRGIN METAL

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The author discusses results of actual foundry operations on valve castings to evaluate the differences in using ingot metal versus virgin metal under identical conditions. The author's findings set forth herein indicate that ingot metal offered many advantages over the use of virgin metal.

THE RELATIVE MERITS of ingot metal versus virgin metal have been a subject of long and heated discussions in brass foundries for many years. When a foundry has decided to use ingot metal in preference to virgin metal, the question arises whether or not the advantages and savings gained by the use of ingot metal are offset by an increase in furnace, foundry and test bench losses; also, whether or not there is a decrease in the mechanical and physical properties of the casting. These questions usually are asked when trouble occurs in the foundry and losses suddenly grow beyond normal expectancy. The practical foundryman, the man in the shop, then attempts to locate the source of trouble. Experience has shown that many factors may be responsible, but the one most frequently blamed is the metal, especially if a new shipment of ingot was used at that time.

During the pioneering days of copper-base ingot production, scrap was generally purchased from the scrap metal dealers. This was roughly sorted by hand, with only a crude guess as to its composition. It was then melted and cast into ingot with little or no attempt to refine or control the impurities. There is no doubt that foundrymen in those days had some justification for their pessimistic attitude toward the use of ingot metal.

Ingot Metal Refining

During World War I and the period immediately following, virgin metals were scarce and the demand for reliable ingot metal increased. This resulted in the development of a highly specialized refining industry in which large reverberatory furnaces replaced most of the crucible and small furnace units. Since that time many firms in the industry have reached a high plane of efficiency. By the use of strict technical control, they now produce a uniform product which meets the rigid standard specifications of the American Society for Testing Materials. Non-ferrous ingot metal necessarily contains iron and nickel in limited quantities, due to their presence in the original scrap. These metals within the limits of the specifications are not injurious. Gardner and Saeger[1] found iron to be advantageous in cast red brass (85 Cu, 5 Sn, 5 Pb, 5 Zn) if the amount was less than 0.5 per cent. The value of nickel is given recognition by A.S.T.M. specifications (1947) which have been revised to consider copper content to be met, if the copper plus nickel (0.75 per cent Max.) comes within the copper range.

Several years previous to World War II, a company operating a large non-ferrous foundry in the middle west, decided to make an extensive production test in order to settle, within its own organization, this controversial question regarding the advantages and disadvantages of ingot metal versus virgin metal. This firm manufactured brass valves, and used an alloy, the composition of which classified it as "Leaded Semi-Red Brass," meeting A.S.T.M. Specification B30-45T Class 5A. The foundry used for this test was modern, fully mechanized, and equipped with a sand conditioning and distribution system. It had modern melting, molding and pyrometric equipment and was operated under strict technical control.

In order to obtain a just comparison over an extended period the following plan was adopted: "The foundry was operated for a period of two months during which only virgin metal plus returned gates and sprues from the resulting castings were used. The foundry was then operated for the following two months in a similar manner with ingot metal plus the resulting gates and sprues." During this test all known factors were supervised and followed by the technical staff. All furnace charges were made up under the supervision of a metallurgist, and followed through the operations of melting, casting, cleaning, inspecting, machining, assembling and final hydraulic testing. All metal was poured under pyrometric control and accurate records were kept throughout the test.

At the time this test was conducted, there was a decided price differential in favor of ingot metal. While this varies from time to time, there has generally been some difference in favor of composition ingot.

Some factors are difficult to evaluate in dollars and cents. Considering such things as: amount of storage room used, time consumed in weighing, in charging furnaces, in breaking up white metals into small pieces and in properly mixing the molten metals, it was apparent that the use of ingot had quite an advantage over that of virgin metals.

During the test an attempt was made to judge the character of the metal. At the beginning, a casting was

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TABLE 1—MELTING RECORD DURING 2-MON. PERIOD

Type Metal Used	Weight of Metal Melted, Lb: Low-Frequency Induction Furnace	Indirect-Arc Furnace	Gas-Fired Crucible Furnace	Total Melted
Virgin	383,215	403,981	56,275	843,471
Ingot	396,197	357,503	68,160	821,860
Total	779,412	761,484	124,435	1,665,331

TABLE 2—MELTING LOSS DURING 2-MON. PERIOD

Type Metal Used	Loss, Lb	Loss, Per Cent
Virgin	15,773	1.87
Ingot	15,579	1.89
Total	31,352	1.88

TABLE 3—CASTING LOSSES DURING 2-MON. PERIOD

Type of Metal	Per Cent Loss Dirty Castings	Per Cent Loss, Misruns	Per Cent Other Losses	Per Cent Loss, Total
Virgin	3.70	1.0	0.55	5.25
Ingot	2.40	0.80	0.60	3.80

TABLE 4—RESULTS OF TEST BENCH INSPECTION

Metal	Valves Tested	Per Cent Body Losses	Per Cent Center Piece Losses	Per Cent Other Losses*	Per Cent Good
Virgin	96924	1.60	0.90	1.40	96.1
Ingot	79728	1.50	0.40	2.00	96.1
Total	176652	1.55	0.65	1.70	96.1

*Defective machining, defective assembling.

selected from each heat. This was then sectioned, polished and given the deep acid etch. The test was unreliable, as it was found that the appearance of the etched specimen was in many cases misleading. Such factors as gating, and thickness and shape of the casting seemed to have more effect than the quality of the metal. Etched sections of valve parts usually showed results as follows:

Stems—Always good dense metal
Bodies—Good, with exception of center end
Tail Pieces—Poor along parting line at gate
Union Nuts—Good
Very tail center pieces—Always poor
Normal center pieces—Good

It was found in some instances that good and poor etched sections could be obtained from the same heat or from the same ladle. The above described procedure required considerable time and effort, and since it failed to furnish information of much value, it was discontinued at the end of the first month.

New Test Procedure

After discarding the above method a new procedure was developed. A test piece was cast by pouring the metal into an impression made in a bucket of molding sand, using a wooden cylinder 1 in. in diameter as a pattern. A test specimen was poured from each heat, and then fractured and examined visually. This test had considerable value, but could not be considered foolproof. In a few cases, heats that produced poor fractures on the specimen, produced castings that showed a good etched section and a good fracture. Using this test the percentage of good dense fractures obtained was higher on heats poured from ingot than from virgin metal.

Melting Furnaces

Three types of furnaces were used in melting the metal during this test. They included a battery of four low-frequency induction furnaces, a battery of three indirect-arc furnaces, and a battery of gas-fired crucible furnaces. An accurate record was kept of the weight melted in each furnace during the respective two-month periods and is shown in Table 1.

The melting loss during these same periods is shown in Table 2.

Considering the total weight of metal melted during the test, it appears that the slight difference of 0.02 per cent between the losses on the two types of metal is negligible.

An accurate record was kept of the foundry losses and all scrap castings were examined before they were returned to the metal repository. An examination of the foundry loss chart showed that for the 18 months preceding this test, the loss amounted to 3.74 per cent. During this 18-month period most of the metal melted was ingot although there was a fair amount of virgin metal used, and the heats were mixed. During the period of the test, the losses were broken down as shown in Table 3.

After the above four months of test, the foundry returned to the use of both virgin and ingot metal, and the loss figure returned to about the pre-test figure, 3.74 per cent.

In this test, the castings were followed through the cleaning, machining, assembling and final testing. After final assembly all valves were subjected to a hydraulic pressure test to weed out defective valves. The record of the test bench inspection is shown in Table 4.

Table 4 shows a small margin in favor of ingot metal in the elimination of leaker losses and indicates that in this respect no benefits are to be derived by the use of virgin metal.

Tensile Strength and Elongation

Failure to meet mechanical properties has frequently been attributed to the metal. During the four-month test period, tensile strength never dropped below 31,000 psi and elongation never below 28 per cent. A.S.T.M. specification for this alloy, B30-45T Class 5A, set a minimum requirement of 29,000 psi tensile and 18 per cent elongation.

The finish of an assembled article such as a brass or bronze valve has considerable effect when selling to the trade. Castings are not uniform in color or appearance as they come from the foundry and this factor is difficult to control. Some foundries overcome this difficulty by giving the casting a bright dip. The general treatment in obtaining uniform color is:

1. Sand or shot blast after removal of gates and sprues.
2. Immerse for 1 min in a solution of
   1 part 36° Bé nitric acid
   2 parts water
3. Rinse thoroughly
4. Dip quickly in a solution of the following mixture
   (a) 2 gal—36° Bé nitric acid
   (b) 8 gal—60° Bé sulphuric acid
   (c) ½ oz hydrochloric acid
5. Rinse thoroughly and quickly dip into following solution
   (a) 1½ oz potasium permanganate
   (b) 16 oz dilute sulphuric acid (1:50 Water)
   (c) 10 gal water
6. Rinse thoroughly and dry on a steam table.

Using the above procedure, it was shown that castings made from ingot metal showed a richer and deeper color than those made from virgin metal.

Conclusions

This thorough test on the production of valve castings, conducted on a strictly impartial basis, proved conclusively that the use of refined copper-base ingot metal of A.S.T.M. specification B30-45T Class 5A, offered many advantages over the use of virgin metal:

1. Metal cost of ingot was considerably less than that of virgin metal at the time this test was conducted.
2. The use of ingot showed a saving in storage room, in time consumed in making up charges, in preparation of metals for weighing and in alloying time.
3. Regardless of the furnace used in melting, fractures of test plugs made from ingot metal were superior to those made from virgin metal.
4. Melting loss was about the same on ingot as on virgin metal.
5. Foundry and test bench losses were lower on castings from ingot than on those from virgin metals.
6. Ingot easily met A.S.T.M. specification requirements for tensile strength and elongation.
7. After chemical treatment, castings from ingot metal had a slight advantage over virgin metal as to appearance.
8. There was no evidence that the advantages obtained by using ingot metal in preference to virgin metal were offset by any disadvantages.

References

1. H. B. Gardner and C. M. Saeger, Jr., "The Effect of Sulfur and Iron on the Physical Properties of Cast Red Brass" (85 Cu, 5 Sn, 5 Zn, 5 Pb), *Proceedings*, A.S.T.M., vol. 33, part II, pp. 448-61 (1933).

British Industries Fair Features New Super-Hard Cast Iron Rolls

IMPROVED CAST IRON ROLLS, whose hardness has been doubled and rolling outputs increased by 300 per cent, were a feature of the British Industries Fair, held May 3-14 in Birmingham and London.

The new rolls, developed as a result of wartime demands, are at least equal to those produced in America, according to their manufacturer, the British Rollmaker's Corp., Ltd., Wolverhampton.

Among the new types of rolls exhibited are superhard cast rolls for light alloy sheets, for continuous strip mills, and rolls with specially machined necks and ground to extremely fine limits for use in mills with roller bearings and force-fed lubrication.

Another exhibitor, Wilsons of Wolverhampton, Ltd., Lichfield, reports the British trend of manufacture of vises and toolholders is from cast iron to fabricated steel, and that demand for weldments has more than doubled during the last year.

The British Industries Fair engineering exhibit has been held annually since 1920, and last year was visited by more than 5,000 buyers from overseas.

Launch British Columbia Campaign For Increasing Foundry Production

Foundries in British Columbia, in cooperation with the British Columbia Research Council, recently began an intensive campaign to increase production and to improve quality of castings.

A detailed survey of foundry production practices, just completed by H. M. Brownrigg of the Council, at the Vancouver Engineering Works, Ltd., is being used as the basis for several research projects, which will eventually lead to large-scale improvements in foundry layout and operations throughout British Columbia.

Following earlier consolidation of the firms now associated with the Vancouver Engineering Works, the projected program marks another step toward Canadian self-sufficiency in the foundry industry.

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GRAY CAST IRON

Some Principles Involved in Heat Treatment

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IT IS THE PURPOSE of this paper to review, in an elementary manner, some of the fundamental principles involved in the heat treatment of cast iron, and to point out certain basic differences between this material and steel as regards transformation behavior during heating and cooling. It has become the custom in recent years for metallurgists to disregard the iron-carbon diagram in discussing the heat treatment of steel, and to interpret results in terms of "S" curves, or time-temperature-transformation diagrams.

This does not mean that the iron-carbon diagram is no longer of importance, but rather that it has become so completely a part of the mental processes of the metallurgist that further reference to it is not needed. The practical interpretation of data is based on rates of reaction in the solid state with the tacit assumption that everyone knows all about the conditions of equilibrium in the iron-carbon system.

In the case of plain carbon steel, this attitude is probably justifiable. In the case of cast iron, however, the metallurgist soon finds that the conditions of equilibrium are not so well known and that they are quite different from those in steel. To illustrate some of these differences, a parallel will be drawn in the following discussion between the behavior on heating and cooling of a plain carbon pearlitic steel of eutectoid composition (about 0.80 per cent carbon) and a plain cast iron of nominal analysis having a pearlitic matrix.

Transformation in Pearlitic Steel

Figure 1 represents a part of the ordinary iron-carbon diagram showing the metastable equilibrium between iron and iron-carbon. The vertical dotted line represents the composition under consideration, a pearlitic steel of 0.80 per cent carbon. At room temperature the metal consists of two phases, ferrite (α) and iron carbide (Ca) lying side by side as pearlite lamellae. Upon heating past the horizontal line AB, the iron transforms into the γ phase and absorbs the carbide lamellae to form a solid solution of carbon in iron called austenite. If time is allowed this austenite becomes a homogeneous single phase γ. At no time does the carbon content of the matrix undergo any change. There is never more or less than 0.80 per cent carbon present.

Upon cooling slowly the reaction is reversed. Austenite breaks down into alternate layers of ferrite (α) and iron carbide (Ca) to re-establish the pearlitic structure. Cooling somewhat more rapidly will delay the transformation and cause it to occur at a temperature below the line AB. The pearlite lamellae then become finer, or more closely spaced. Still more rapid cooling may suppress the transformation temperature to as low as 1200 F, and extremely fine pearlite lamellae will be formed.

Drastic cooling, such as quenching, will suppress the lamellar type of transformation completely and allow the austenite to persist down to a temperature below 500 F, at which time the austenite breaks down into an entirely different type of structure called martensite, which is characterized by a needle-like or acicular pattern. Between the temperature range for the formation of martensite and that of fine pearlite, a variety of acicu-

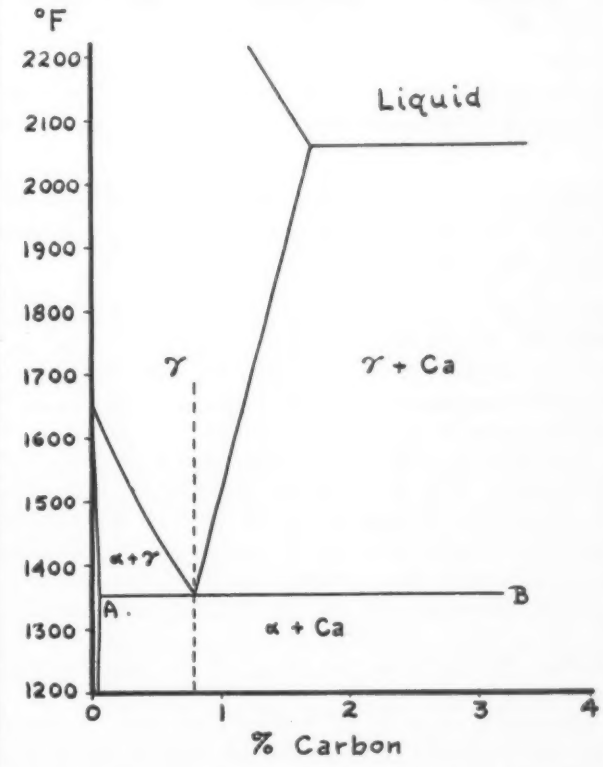

Fig. 1—Part of the ordinary iron-carbon diagram showing metastable equilibrium between iron and iron-carbide.

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lar structures form, depending on the amount of time allowed and the rate of transformation at any particular temperature level.

Since the physical properties of the steel depend on the type of structure obtained on cooling, the metallurgist is naturally much concerned with the rate of formation of these various structures and interprets his heat treating results of time-temperature-transformation diagrams rather than in terms of the simple equilibrium diagram shown in Fig. 1.

Transformation in Pearlitic Cast Iron

Before entering into a discussion of the corresponding transformation in cast iron, it is necessary to give some consideration to the two types of equilibrium which occur in cast iron, the stable and the metastable. Gamow [1] has used a very clear analogy to illustrate what is meant by these basic terms, and his description and illustration (Fig. 2) are given as follows:*

"In order to understand this important concept, suppose, for example, that we pour a quantity of water into a deep hole in the ground (Fig. 2A). If no external work is done to extract this water from the hole,

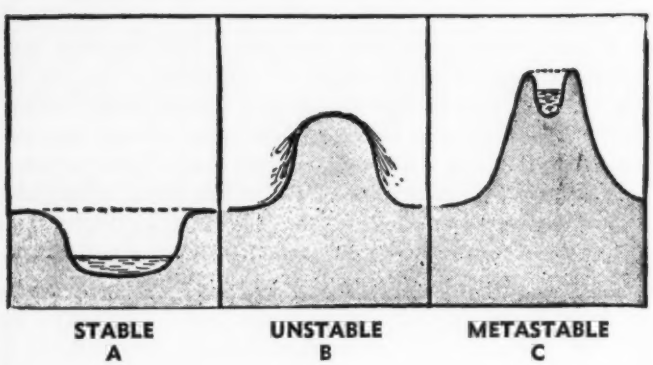

Fig. 2—Gamow's mechanical interpretation of the notion of stable, unstable, and metastable states.[1]

it will remain there indefinitely and will never get out by itself. We say the water in such a hole is in a *stable* state of equilibrium.

"If on the contrary, instead of pouring the water into a hole, we pour it on top of a sugar loaf mountain (Fig. 2B), it will not stay there at all and will at once come down in a stream on both sides. The position of the water on the top of such a mountain is *unstable* and can never be realized in practice.

"Let us now consider the water filling a crater of an old volcano (Fig. 2C). If left to itself, the water will stay there just as long as in the hole in the ground, although in principle much energy can be obtained from bringing it to a lower level. We need, however, to bring the water over the rim of the crater, supplying for this purpose a certain amount of energy from the outside. We say that the water in the crater is in a *metastable* state."

The stable state in all iron-carbon alloys is one of iron and graphite. The metastable state is one of iron and iron-carbide. In steel, the metastable state persists indefinitely under ordinary conditions of heating and cooling, and the metastable diagram shown in Fig. 1 is adequate to define its transformation behavior. Gray cast iron, however, because of its much higher carbon and silicon content, exhibits both the stable and metastable states under ordinary rates of heating and cooling. It is, therefore, necessary to construct two diagrams, one representing the stable condition and one the metastable.

Schematic diagrams of this kind are shown in Figs. 3 and 4. Complete equilibrium, according to either diagram, is seldom obtained under ordinary circumstances, the final result usually being a mixture of both. Using Gamow's analogy, part of the water in the volcanic crater may be considered as getting over the edge and reaching a stable condition. Some of the water, however, remains in the crater in a metastable state. This dual behavior is of fundamental importance and constitutes a basic distinction between cast iron and steel.

Transformation According to the Metastable State

For this purpose it will be considered that a cast iron in which no free graphite occurs, i.e., under all conditions of heating and cooling the carbon is either in the form of iron carbide or in solid solution in the austenite. A diagram representing this metastable condition is shown in Fig. 3. The total carbon present is, say, 3 per cent, represented by the vertical dotted line.

At room temperature the metal consists of pearlite $(a + Ca)$, together with massive particles of free carbide (Ca), i.e., it is a white iron. Except for the presence of the massive carbide particles, the metal is exactly like the pearlitic steel previously described. Two phases occur: ferrite (a) and iron carbide (Ca).

The metal is now heated into the temperature region marked $a + \gamma + Ca$ in Fig. 3. Some of the iron now transforms to the γ phase and begins to absorb the carbide of the pearlite lamellae to form a solid solution of carbon in γ iron (austenite), in exactly the same manner as the pearlitic steel behaved on heating. The massive free carbide remains undisturbed.

As the metal is gradually heated through the region $a + \gamma + Ca$, the amount of austenite (γ) increases and the amount of pearlite $(a + Ca)$ decreases until, at a temperature just above the line CD, the matrix consists entirely of austenite holding in solid solution 0.70 per cent carbon (Point C). At this stage, the massive free carbide still is intact and undisturbed.

Carbon in Solid Solution

Suppose the temperature is raised considerably above the line CD. In this case the austenite begins to dissolve some of the massive carbide and the amount of carbon held in solid solution increases. At any temperature above the line CD, the amount of carbon in solid solution in the austenite may be determined by projecting horizontally from the dotted line to the left to intersect the line CE and then reading off the percentage of carbon on the scale at the bottom of the diagram. At 1800 F, for example, the austenite will hold in solid solution about 1.15 per cent carbon. The remainder of the 3 per cent carbon still is present as massive free carbide particles.

Upon slowly cooling the metal from 1800 F the reverse changes take place. Some of the carbon in solid solution in the austenite (γ) is deposited again, either on the surfaces of the massive carbide particles or as separate particles until, at the temperature of the line

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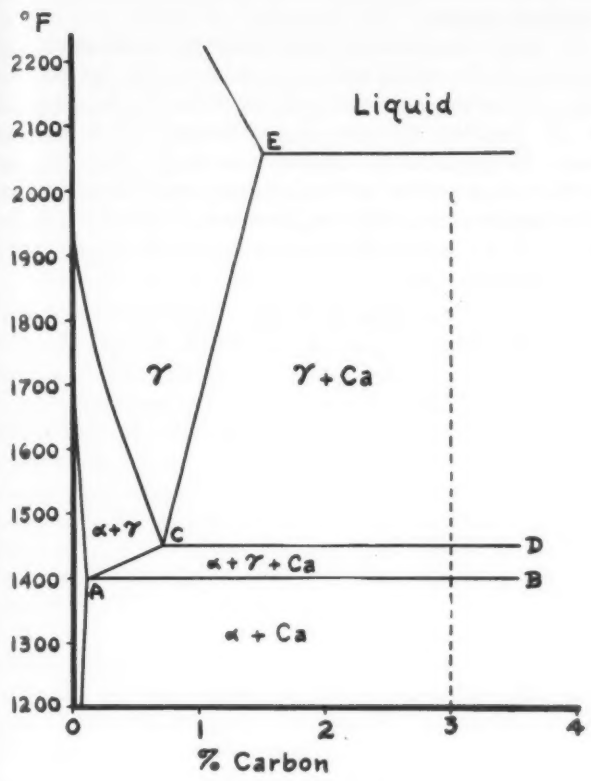


Fig. 3—Schematic diagram showing the conditions of metastable equilibrium in cast iron. Note that the lines are somewhat different from those in Fig. 1. These changes are caused by the presence of silicon in the metal. The eutectoid point "C" is placed at 0.70 per cent carbon and a new region $a + \gamma + Ca$ appears in the diagram. This diagram represents a silicon content of about 1.90 per cent.

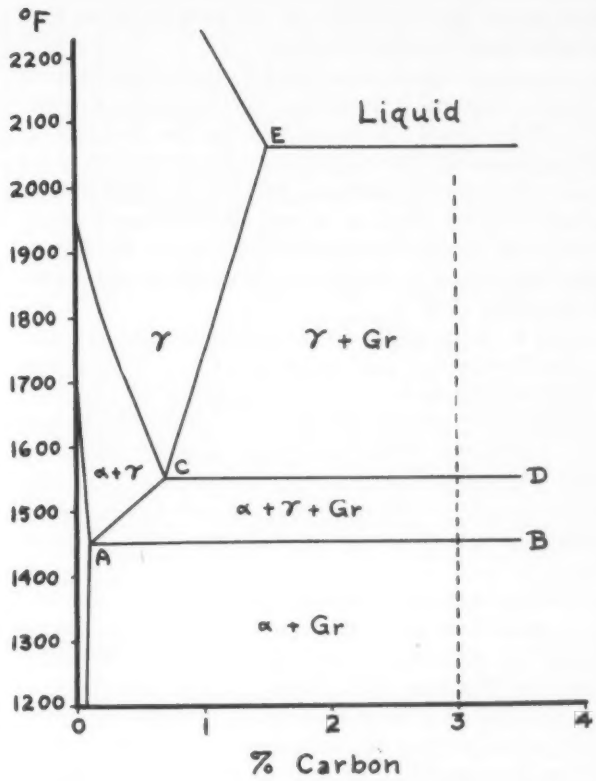


Fig. 4—Schematic diagram showing the conditions of stable equilibrium in cast iron. The eutectoid point "C" has been placed at 0.70 per cent carbon to correspond with Fig. 3. The region $a + \gamma + Gr$ is somewhat wider than the $a + \gamma + Ca$ region of Fig. 2. This diagram was drawn to represent a silicon content of about 2.20 per cent. All the lines will shift position with changes in silicon content.

CD, the austenite is again of composition *C*, holding 0.70 per cent carbon in solid solution.

When the metal cools further into the region $a + \gamma + Ca$, some of this austenite (γ) begins to break down into alternate layers of ferrite (a) and carbide (Ca), forming pearlite. With falling temperature, the amount of austenite (γ) decreases while the amount of pearlite ($a + Ca$) increases until transformation is finally complete at the line *AB*.

After crossing the line *AB* in cooling, the metal will be back again where it started and will consist of pearlite ($a + Ca$) plus massive particles of free carbide (Ca). Under conditions of more rapid cooling, the matrix can be made to undergo all the structural modifications mentioned in the case of the pearlitic steel, i.e., finer and finer pearlite lamellae, or transformation into martensite or other acicular patterns, depending on the conditions of cooling. In all these cases the massive free carbide remains intact as a part of the final mixture without entering into the actual transformation in any way.

In describing the metastable transformation, it was assumed that no free graphite was formed at any stage of heating or cooling. The opposite extreme, the stable state, is a case in which no free iron carbide is present at any temperature level. A diagram representing this stable condition is shown in Fig. 4. The similarity of this diagram to the metastable diagram (Fig. 3) is apparent, the only difference being that the notation *Ca* (carbide) has been changed to *Gr* (graphite), and that the position of the lines, with respect to temperature, has been altered somewhat.

Transformation According to the Stable State

To trace out the transformation according to the stable system, a start will be made with a cast iron of 3 per cent total carbon in a fully stable condition. The matrix in this case consists of nothing but ferrite (a) in which graphite flakes (Gr) are imbedded. Upon heating into the region $a + \gamma + Gr$ (Fig. 4), part of the ferrite (a) transforms into austenite (γ) and begins to dissolve carbon from the surfaces of the graphite flakes.

At successively higher temperatures, the amount of austenite (γ) increases while the amount of ferrite (a) diminishes until, at the temperature of the line *CD*, the entire matrix consists of austenite holding in solid solution 0.70 per cent carbon (Point *C* in Fig. 4). The graphite flakes are now somewhat thinner than they were to begin with, having lost some carbon by solu-

tion to the matrix. At temperatures above the line *CD*, the austenite continues to dissolve carbon from the graphite flakes and will hold, at, say 1800 F, about 1.10 per cent carbon in solid solution.

Upon cooling slowly from 1800 F, the reverse action takes place. Carbon is deposited on the surfaces of the graphite flakes until the metal reaches the line *CD*, at which temperature the austenite again holds in solid solution 0.70 per cent carbon (Point *C*). The amount of carbon in solid solution at any intervening temperature may be determined by projecting to the left to intersect the line *CE* exactly as was done in the metastable diagram (Fig. 3).

At 1550 F (Line *CD*), the austenite begins to transform into ferrite (α) and graphite (*Gr*). This action is strictly analogous to the transformation of austenite into ferrite (α) and iron carbide (*Ca*) in the metastable system. The stable transformation, however, does not produce a lamellar structure of ferrite and graphite, similar to pearlite. The graphite formed during transformation is deposited on the surfaces of the graphite flakes.

As cooling continues through the region $\alpha + \gamma + Gr$, the amount of austenite (γ) decreases while the amount of ferrite (α) increases until transformation is finally complete at the line *AB* (1450 F). At any stage of transformation, the total amount of carbon remaining in solid solution may be determined by projecting to the left to intersect the line *AC*. At 1500 F, for example, about one half of the matrix will consist of austenite (holding in solid solution 0.70 per cent carbon) and the total amount of carbon in this remaining austenite will be about 0.35 per cent.

After cooling past the line *AB*, the metal will be back again where it started and will consist of two phases, a matrix of ferrite (α) in which the graphite flakes (*Gr*) are imbedded. The graphite flakes will now be back to their original thickness, all the carbon dissolved during heating having been restored during cooling and transformation.

Transformation in Cast Iron According to Both Stable and Metastable States

In the metastable transformation of cast iron, it was noted that the matrix could be made to assume all the structural variations produced in eutectoid steel by altering the conditions of cooling. This is not true of the stable system. The stable transformation produces ferrite and graphite, and the graphite so produced is invariably deposited on the surfaces of the graphite flakes present in the matrix. Coarse and fine lamellar structures or acicular structures, such as exist after metastable transformation, have no direct analogues in the stable system.

The term "stable transformation," as defined in the foregoing, must not be confused with the graphitization of pearlite. Careful studies have shown that the austenite during stable transformation breaks down into ferrite and graphite without the intervention of any metastable phase. This concept of stable transformation must be kept clearly in mind in all the discussion which follows.

With these two extreme cases of stable and metastable transformation in mind, we may proceed to the case where both types of transformation occur simultaneously in the same piece of metal, as frequently happens in ordinary heat treatment. We will begin with a gray cast iron of 3 per cent total carbon having a fully pearlitic matrix.

At room temperature this material obviously represents both the stable and metastable states, the graphite flakes representing the stable state and the iron carbide of the pearlite lamellae representing the metastable state. Going back to Gamow's analogy (Fig. 2), part of the water in the volcanic crater may be considered as getting over the edge and reaching a stable condition. Some of the water, however, remains in the crater in a metastable state.

Reversion to Stable Condition

Upon heating the pearlitic gray iron to a temperature near the line *AB* in Fig. 4, the carbide of the pearlite lamellae will begin to graphitize. If time is allowed all the pearlite will decompose and the graphite so formed will be deposited on the surfaces of the graphite flakes. If a piece of cast iron is held for a considerable time at a temperature just below the line *AB* in Fig. 4 and then quenched, it will be found to consist entirely of ferrite (α) and graphite (*Gr*). The metal has reverted to the stable condition before any transformation to austenite has taken place.

Under ordinary rates of heating, much of the pearlite will remain intact until the metal reaches the transformation range. Transformation then begins exactly as described under the metastable system (Fig. 3). Some of the iron begins to transform into austenite (γ) and absorbs the carbide of the pearlite lamellae. This action continues as the metal is heated through the region $\alpha + \gamma + Ca$ until, at a temperature above the line *CD*, the matrix will consist entirely of austenite (γ) holding in solid solution 0.70 per cent carbon.

Upon heating to higher temperatures the austenite will dissolve carbon from the surfaces of the graphite flakes exactly as was described under the stable system (Fig. 4), and the amount held in solid solution at any temperature level may be determined as before by projecting to the left to intersect the line *CE*.

Suppose the heating process is stopped at some temperature within the region $\alpha + \gamma + Gr$ in Fig. 4, say at a temperature of 1500 F. If given time the metal will now revert to the stable state. The carbide of the pearlite lamellae will break down and deposit carbon on the surfaces of the graphite flakes. After holding at 1500 F for some time the matrix will then consist of about one half free ferrite (α) and one half austenite (γ). A piece quenched in this condition will show a matrix of one half ferrite and one half martensite.

Quenching Temperature Effect

Any combination of free ferrite and martensite can be obtained by quenching from various temperatures within the region $\alpha + \gamma + Gr$ of Fig. 4. Quenching from temperatures near the lower line *AB* will produce nearly all ferrite. Quenching from temperatures near the upper line *CD* will produce nearly all martensite. To produce a fully martensitic matrix, the metal must be heated to a temperature above the region $\alpha + \gamma + Gr$. It must be made fully austenitic before quenching.

When a pearlitic steel is heated to a temperature sufficient to become fully austenitic it is said to be austenized. If the surface of the steel loses carbon by chemical action during heating, it is said to be decarburized. If the surface absorbs carbon by contact with

carbonaceous matter during heating, it is said to be carburized. Applying these commonly used terms to pearlitic gray iron, its behavior on heating may be summed up in the following statements:

1. The matrix of pearlitic gray iron may be completely decarburized by heating it to temperatures just below the line *AB* in Fig. 4.

2. Metal so treated may be carburized again, up to a maximum of 0.70 per cent carbon, by heating it into the region $a + \gamma + Gr$ in Fig 4, the degree of carburization being a function of temperature.

3. The matrix can be further carburized beyond 0.70 per cent carbon by heating it above the line *CD* in Fig. 4, the degree of carburization being again a function of temperature.

4. The matrix can be partially austenized by heating to temperatures within the region $a + \gamma + Gr$, the amount of austenite so produced being a function of temperature. No amount of holding time within the $a + \gamma + Gr$ region will produce a fully austenitic condition.

5. The matrix can be fully austenized by heating to temperatures above the region $a + \gamma + Gr$ in Fig. 4.

The reason for these changes lies in the fact that gray iron reacts on heating according to both the stable and metastable states, and that it has its own internal carburizer provided in the form of graphite flakes scattered through the matrix.

Hardness and Quenching Temperatures

An example of what happens when cast iron is quenched from temperatures within the region $a + \gamma + Gr$ is shown in the work of Walls and Hartwell.[2] Their results are given in Fig. 5. Specimens quenched from 1100 F had about the same hardness as the original bars. Quenching from successively higher temperatures up to 1400 F caused a progressive decrease in hardness. This was caused by a gradual breakdown of pearlite into ferrite (a) and graphite (Gr) below the transformation range, the amount of such breakdown increasing with increasing temperature. The metal was in the region $a + \gamma + Gr$ of the stable diagram (Fig. 4).

At 1450 F the hardness after quenching started to increase. Part of the ferrite (a) had now transformed into austenite (γ) during heating, and this austenite formed martensite on quenching. The metal had now entered the temperature region $a + \gamma + Gr$ of Fig. 4. In the lower part of this $a + \gamma + Gr$ region only a small amount of austenite formed, and the hardness after quenching was still quite low. At 1500 F about half of the matrix was austenite (γ) and the hardness after quenching reached 375 Brinell.

The metal at this temperature was in the middle of the $a + \gamma + Gr$ region. At 1550 F the matrix was nearly all austenite (γ) and the ferrite (a) had almost disappeared. The metal was now at the top of the $a + \gamma + Gr$ region and developed a Brinell hardness of around 475 on quenching. Heating to 1600 F assured complete elimination of all the ferrite (a) and the matrix was fully austenized throughout. It was now in the region $\gamma + Gr$ of Fig. 4 and gave full hardness on quenching. Specimens heated to 1650 F and 1700 F were likewise fully austenized and gave full hardness on quenching.

The point to be emphasized is that no amount of holding time in the region of $a + \gamma + Gr$ will produce a fully austenitic matrix. Specimens could have been held for hundreds of hours at 1500 F, for example, and would still have remained a mixture of ferrite (a), austenite (γ), and graphite (Gr). The exact boundaries of this region of three-phase equilibrium are determined largely by the silicon content of the metal.

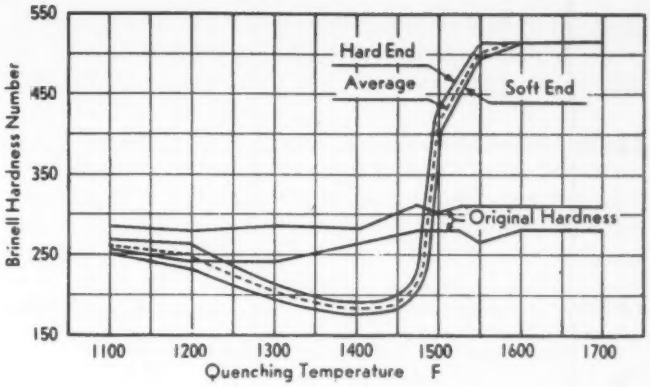


Fig. 5—Brinell hardness as affected by quenching temperature. Bars of 3-in. length by 5/8-in. diameter, water quenched. Analyses of bars follow: [2]

Component	*Per cent*	
Silicon	*2.16*	*2.23*
Total Carbon	*3.39*	*3.28*
Sulphur	*0.055*	*0.049*
Phosphorus	*0.187*	*0.196*
Manganese	*0.84*	*0.71*
Chromium	*0.22*	*0.16*
Molybdenum	*0.68*	*0.78*

Figure 4 was drawn for a silicon content of about 2.20 per cent.[3] The precise limits of the $a + \gamma + Gr$ region for a wide variety of cast iron analyses have not been worked out experimentally. For practical purposes, it is sufficient to determine the lowest temperature from which a small specimen will give a fully martensitic matrix on quenching. This will define the upper limit (Line *CD*) of the $a + \gamma + Gr$ region for any particular analysis of iron. An iron of 1.40 per cent silicon may become fully austenitic at 1500 F, while one containing 3.50 per cent silicon may require a temperature of over 1700 F to reach a similar condition.

Mixed Stable and Metastable Transformation on Cooling

Both the stable and metastable transformations also occur under moderately slow conditions of cooling. In order for a cast iron to follow completely the stable transformation diagram shown in Fig. 4, it must be cooled very slowly. Ordinarily some metastable transformation to pearlite takes place, and the amount formed depends on the relative rates of the stable and metastable transformations in any particular composition.

To illustrate what is meant, we will start with a gray cast iron containing 3 per cent carbon and 2 per cent silicon, sand cast into bars one inch in diameter. The metal as-cast consists of type *A* graphite flakes in a fully pearlitic matrix. A bar is now heated to 1600 F, and held for one hour. The matrix then becomes austenite holding in solid solution about 0.80 per cent carbon, i.e., it is just above the $a + \gamma + Gr$ region in Fig. 4.

After soaking for one hour at 1600 F, the bar is cooled in air. Examination will now show that the matrix is no longer all pearlite. Some free ferrite will be found along the surfaces of the graphite flakes. Even

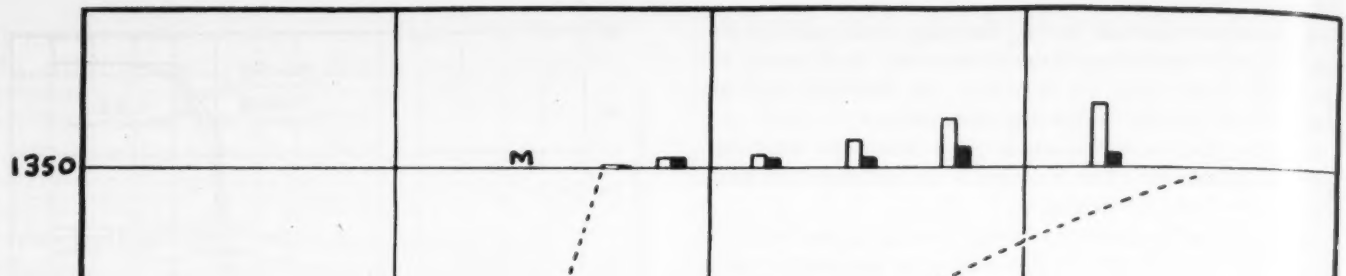


Fig. 6—Relative rates of stable and metastable transformation under conditions of isothermal treatment. The heights of the vertical bars show the relative amounts of free ferrite and pearlite. White bars represent ferrite—black bars pearlite.[3]

Analysis of Material, per cent

TC	Si	S	P	Mn
3.03	2.34	0.063	0.097	0.70

if the bar is cooled somewhat faster, as by blowing with a stream of compressed air, it will still show some free ferrite along the graphite flakes.

This means that a part of the austenite has transformed according to the stable system to form ferrite and graphite ($a + Gr$) while the remainder has transformed according to the metastable system to form pearlite ($a + Ca$). Since the stable transformation always involves a diffusion of carbon to the graphite flakes, it is natural that the ferrite layers should form along the surfaces of the flakes, i.e., in those parts where such carbon diffusion could occur most easily.

Again it is emphasized that the ferrite layers are not a result of the graphitization of pearlite. Careful studies have shown that the ferrite forms by direct transformation, and that its formation begins before any pearlite starts to develop in the matrix.

If a thermocouple were imbedded in the bar, it would indicate that transformation did not take place at the temperatures shown in Figs. 3 and 4, but actually occurred at about 1325 F. The metal was, therefore, undercooled considerably below equilibrium conditions. The fact that the metastable transformation of austenite into pearlite is accelerated at temperatures below the equilibrium range is well known.

If the austenite in 0.80 per cent carbon steel is undercooled to a temperature of around 1200 F, for example, it will transform completely to fine pearlite in a matter of seconds. In cast iron the stable transformation of austenite to ferrite and graphite is likewise accelerated by undercooling, but not to the same degree as the metastable transformation.

Figure 6 illustrates the relative rates of the two reactions in an ordinary cast iron of the composition given. Note that, at temperatures of 1350 and 1300 F, the stable transformation proceeds more rapidly than the metastable transformation. At temperatures of 1250 and 1200 F the reverse is the case, and the metastable transformation proceeds more rapidly than the stable transformation. These specimens were heated to 1600 F, to produce austenite containing about 0.80 per cent carbon in solid solution, and were then quenched into molten lead and held at constant temperature during transformation.

Such conditions are different from those of continuous cooling and favor the stable transformation because more time is available for the diffusion of carbon to the graphite flakes. Figure 6, therefore, indicates the "tendency" of the metal to follow the stable transformation at any given constant temperature level. What happens during continuous cooling is determined by this tendency, plus the amount of time available for carbon diffusion to the graphite flakes.

In the cast iron bar cooled in air from 1600 F, for example, it may be found that transformation occurs at 1325 F and requires about one minute to reach completion. What develops in the final structure is then determined by the following factors:

1. The tendency of the metal to follow the stable transformation under conditions of undercooling.

2. The time available for the diffusion of carbon to the graphite flakes, and the rate of such diffusion at the temperature in question.

These factors govern the amount of free ferrite which will be formed along the surfaces of the graphite flakes. The remainder of the austenite will transform according to the metastable system and produce pearlite.

Returning now to the structure of the as-cast bar, which was fully pearlitic, the question arises: If the matrix was fully pearlitic after cooling in the mold, why is not the pearlitic condition re-established by heating it above the transformation range and cooling again at the same rate that the casting cooled originally? This question has not been satisfactorily answered, but the following factors may be involved.

A casting cooling continuously in the mold is in a state of continual flux as regards the diffusion of carbon to the graphite flakes. Just after solidification the austenite holds in solid solution about 1.50 per cent carbon (determined in Fig. 4 by projecting to the left to intersect line *CE*, as previously described).

As this austenite cools and approaches the transformation range, it diffuses carbon to the graphite flakes, i.e., it tries to reach a condition of equilibrium at each successively lower temperature level. The casting, however, is cooling continuously and does not necessarily wait for the austenite to reach equilibrium throughout its entire mass. The first part of the austenite to reach eutectoid composition (0.70 per cent C) is undoubtedly that in direct contact with the surfaces of the graphite flakes.

Diffusion processes always involve a composition gradient, and in this case the lower carbon content in the austenite will be in the direction of diffusion, i.e., toward the flakes. Transformation, therefore, starts with the formation of nodules of pearlite at various points along the flakes.*

At the time the pearlite nodules start growing, the austenite more remote from the flake surfaces still is above eutectoid composition and continues to diffuse carbon through whatever spaces are open between the growing nodules of pearlite. We must think of this mechanism as a dynamic condition in which the austenite is continually striving to reach a condition of equilibrium with falling temperature.

Composition and Cooling Rate

If the silicon content is correct for the cooling rate involved, the austenite will just reach a condition of metastable equilibrium at the flake surfaces and the entire matrix will transform into pearlite. If the silicon content is too high, some of the austenite at the flake surfaces will reach a condition of stable equilibrium and layers of ferrite will form along the flakes. Foundrymen have learned to balance composition against cooling rate so as to produce a fully pearlitic matrix in a given size of casting.

When a cast iron bar of balanced composition, which is fully pearlitic as-cast, is reheated again to produce austenite, the dynamic conditions mentioned in the foregoing are not necessarily re-established. Reheating to 1600 F, for example, produces a uniform homogeneous austenite holding about 0.80 per cent carbon in solid solution.

This homogeneous austenite may be quite different, as regards carbon distribution, from the austenite which existed in the original casting after it had cooled to 1600 F in the mold. When the homogeneous austenite in the reheated bar is cooled again at the same rate as the original casting, it does not necessarily transform in exactly the same manner. Conditions for carbon diffusion as this homogeneous austenite cools are more favorable to stable transformation, and some free ferrite is likely to form at the surfaces of the graphite flakes.

Reheating the bar to 1800 F will come nearer to the condition of the original casting, and it will be found that less free ferrite forms after cooling from 1800 F.[3] A temperature near the melting point would probably be required to approach the actual conditions existing in the original cast iron bar as it cooled continuously in the mold.

Mixed Transformation Under Conditions of Isothermal Treatment

Mixed transformation, according to both stable and metastable states, may be a factor of some importance in the isothermal transformation of cast iron, i.e., cases where the metal is first heated to produce a fully austenitic matrix and then cooled suddenly to some subcritical temperature and allowed to transform at a constant temperature level. The rate at which the austenite transforms under these conditions varies considerably at different temperature levels.

Figure 7, taken from the work of Flinn, Cohen, and Chipman,[4] shows the time required for transformation to begin and end in a series of cast irons containing various amounts of alloying elements. Figure 8 shows the range of hardness values obtained after isothermal transformation at various temperatures. All these specimens were heated to 1600 F and held for 25 min prior to quenching. They were, therefore, fully austenized and the austenite held in solid solution about 0.80 per cent carbon.

Taking the case of the plain cast iron (Curve 3 in Fig. 7), some of the structures obtained after isothermal treatment will now be described, using the data given by the authors. Specimens transformed at 1300 F contained free ferrite, indicating that some of the austenite had transformed according to the stable state while the remainder transformed into pearlite.

Specimens treated at 1250 F likewise showed free ferrite (compare with Fig. 6). At lower temperatures the amount of ferrite decreased and the pearlite lamellae become finer, causing the rapid rise in hardness shown on the right-hand side of Fig. 8. The fastest rate of transformation in Heat No. 3 occurred at 1200 F, and was complete in 20 sec. Below this temperature level, the rate of transformation slowed very decidedly. At 1000 F, for example, transformation required 1000 sec to reach completion (Fig. 7).

Acicular Type Structures

At around 900 F the lamellar transformation to fine pearlite no longer took place, and the structures changed over to the acicular type. A specimen of Heat No. 9, partially transformed at 900 F, exhibited an interesting condition which merits discussion in some detail. Transformation in this case started with the formation of needle-like particles of free ferrite, which the authors term acicular ferrite. From their explanation, this was just ordinary ferrite containing only traces of carbon.

A specimen of Heat No. 3, fully transformed at 800 F, was found to contain 90 per cent acicular ferrite, the remainder of the matrix being an intimate ferrite-carbide aggregate. Since the original austenite contained about 0.80 per cent carbon in solid solution, the

*This process has been observed in actual castings while they were cooling in the mold.

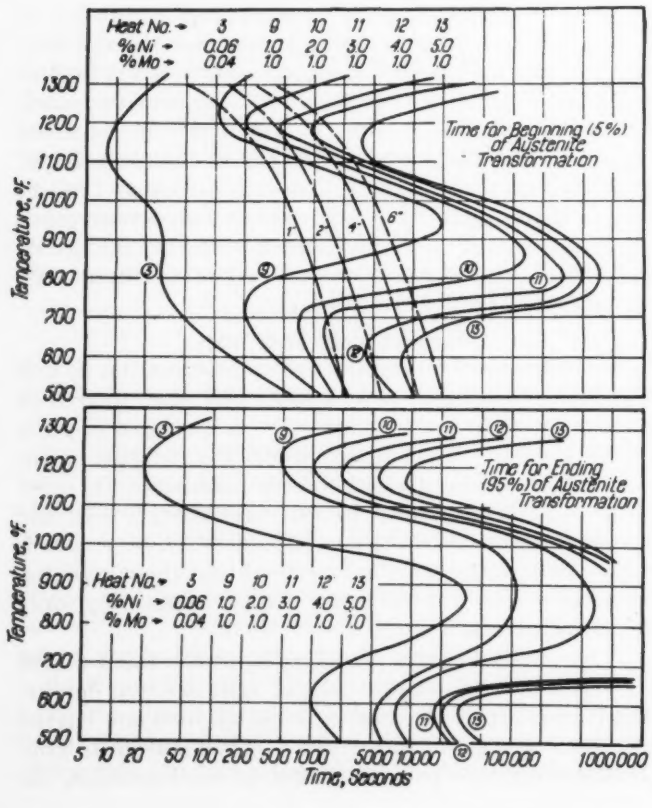
question naturally arises: What became of the carbon which was rejected by the 90 per cent of acicular ferrite as it grew during transformation?

Dr. Chipman was of the opinion that this carbon was concentrated into the 10 per cent of remaining austenite, which was thereby greatly overloaded with carbon. When this greatly overloaded austenite finally transformed at 800 F, its burden of excess carbon would then be rejected as free carbide particles. X-ray diffraction studies, however, did not reveal any such excess of free carbide particles after transformation.

An alternative explanation is to consider that the excess carbon of the overloaded austenite simply diffused to the surfaces of the graphite flakes, which were near at hand and in direct contact with the austenite itself. It will be noted in Fig. 7 that the time required for the austenite to transform at 800 F was extremely long, amounting to over 10,000 sec (more than 2 hr). If the carbon had time to diffuse out of the acicular ferrite into the austenite, it would also have had time to diffuse out of this austenite and deposit on the surfaces of the graphite flakes.

This process of the diffusion of carbon to the graphite flakes with the attendant formation of free acicular ferrite is precisely equivalent to the mechanism of stable transformation previously described under the stable equilibrium diagram (Fig. 4). If such a mechanism

Fig. 7—Transformation curves for cast irons showing the effect of nickel and molybdenum on the times for the beginning and ending of austenitic transformation at constant subcritical temperatures. Base Analysis: 2.5 per cent total carbon, 2.5 per cent silicon, 0.85 per cent manganese, 0.10 per cent sulphur and phosphorus. Cooling curves for 1, 2, 4 and 6-in. diameter castings are shown with zero time taken at 1350 F. Flinn, Cohen, and Chipman.[4]



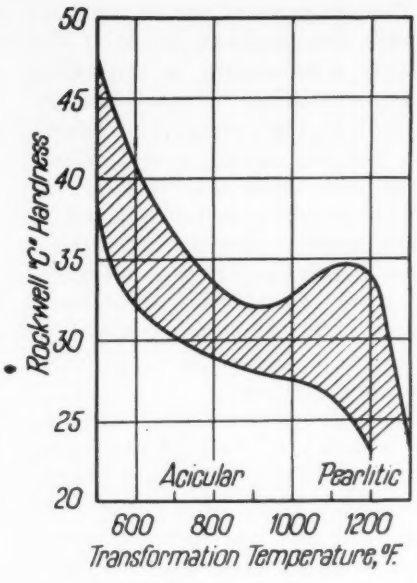


Fig. 8—Range of hardness values found for thirteen nickel-molybdenum cast irons at the end of isothermal transformation. Flinn, Cohen, and Chipman.[4]

occurs isothermally at 800 F, it simply means that the metal is following a mixed transformation according to both the stable and metastable states.

Two temperature levels thus appear to favor the formation of free ferrite during isothermal transformation; one in the range from 1350 to 1200 F (see Fig. 9), in which free ferrite develops along the surfaces of the graphite flakes, and a second between 900 and 700 F in which free acicular ferrite is formed.

The formation of free acicular ferrite was responsible for the dip in the hardness values shown in the middle part of Fig. 8. At temperatures below 800 F, the amount of acicular ferrite decreased and the hardness of the matrix increased rapidly, as shown on the left-hand side of Fig. 8.

A whole series of acicular type structures was obtained at temperatures between 800 and 500 F, similar in every way to the structures obtained by the isothermal transformation of steel. This study was not carried to temperatures below 500 F, but it is known from other work that cast iron transforms into martensite at temperatures below 500 F in the same general manner as steel.

The time required for transformation to begin and end at any temperature level is easily determined by consulting Fig. 7, which illustrates the marked effect of molybdenum and nickel on the transformation behavior. The curves in Fig. 7 resemble those found for many alloy steels, and show that alloying elements influence the transformation of cast iron in a similar manner.

In general, the alloy additions serve to slow up the rate of transformation in the temperature range between 1300 and 1100 F, so that a casting may readily be cooled through this range without forming any pearlite. Having passed through the temperature range in which pearlite forms, the austenite will then transform at some lower temperature to produce a hardened matrix. It is thus possible to harden a large section all the way through without subjecting it to drastic quenching.

If sufficient alloys are added a heavy casting may be hardened all the way through by simply heating it to produce austenite and then cooling it in air. Acicular structures can also be obtained directly on casting by

suitable alloy conditions. Such castings may be considered as being heat treated in the mold.

Two other factors should be mentioned before closing the discussion. These are the effect of the graphite flake pattern and the effect of segregation. The presence of graphite flakes in cast iron is an open invitation for the metal to transform according to the stable state.

Additional Factors Influencing Transformation

In steel the metastable transformation of austenite to pearlite ($\gamma \rightarrow \alpha + Ca$) is said to be nucleated by carbide. The stable transformation ($\gamma \rightarrow \alpha + Gr$) may be considered as being nucleated by graphite. The reaction therefore begins at points where a graphite surface is in direct contact with austenite, i.e., along the surfaces of the graphite flakes.

Stable transformation ($\gamma \rightarrow \alpha + Gr$) does not produce a lamellar structure of ferrite and graphite, analogous to the structure of pearlite. The existence of the eutectoid point (C) in the stable diagram (Fig. 4) is no indication in itself that a lamellar structure of $\alpha + Gr$ *must* form during transformation. Point C in Fig. 4 simply defines the limiting concentration of carbon remaining in solid solution in the austenite (γ) after it has cooled to a temperature of 1550 F.

The anticipated lamellar graphite eutectoid structure does not develop when this austenite undergoes stable transformation. Metallurgists, to satisfy fixed habits of thought, say that the graphite eutectoid is divorced. It is simpler to say that there was no marriage to begin with.

In the metastable transformation ($\gamma \rightarrow \alpha + Ca$), carbon diffuses to a lamination of carbide and layers of ferrite form adjacent to layers of carbide. This aggregate is called pearlite in steel. In the stable transformation ($\gamma \rightarrow \alpha + Gr$) carbon diffuses to a graphite flake and a layer of ferrite forms adjacent to a layer of graphite. This aggregate is called primary ferrite in cast iron. The mechanism is fundamentally the same in both cases; the final aggregate is entirely different.

It would be expected that the amount of primary ferrite in the final aggregate would be influenced by the size, shape, and distribution of the graphite particles present in the austenitic matrix at the time it started to transform. The greater the graphite-austenite interface, the greater will be the opportunity for stable transformation.

For illustration purposes, imagine a 1-in. cube of iron-silicon alloy having at its center a single sphere of graphite ¼-in. in diameter, and assume that the cube has been heated and consists of homogeneous austenite having 0.70 per cent carbon in solid solution, ready to transform. During cooling in air, say that there was sufficient time for diffusion to produce a layer of ferrite around the sphere of graphite, this ferrite layer being 0.01 in. thick. The ferrite layer would develop by stable transformation ($\gamma \rightarrow \alpha + Gr$).

The remainder of the cube would form pearlite by metastable transformation ($\gamma \rightarrow \alpha + Ca$). If the cube were then sampled for analysis, by reducing the whole thing to chips and mixing thoroughly, the "combined carbon" result would show almost 0.70 per cent, or practically the same amount held in solid solution by the original austenite.

Suppose now that the same ¼-in. diameter sphere of graphite is reduced to many small spheres, and that these are scattered through the same 1-in. cube of iron-silicon alloy so that the distance between the small spheres is 0.01 in. The cube is now heated and cooled exactly as before. A layer of ferrite 0.01 in. thick will again form around each small sphere of graphite.

Since the distance between spheres is only 0.01 in., it is evident that the ferrite layers will merge completely during transformation to produce a fully ferritic matrix and no combined carbon would be found by analysis. Any intermediate amount of combined carbon could obviously be obtained by adjusting the size and spacing of the graphite spheres in the iron cube.

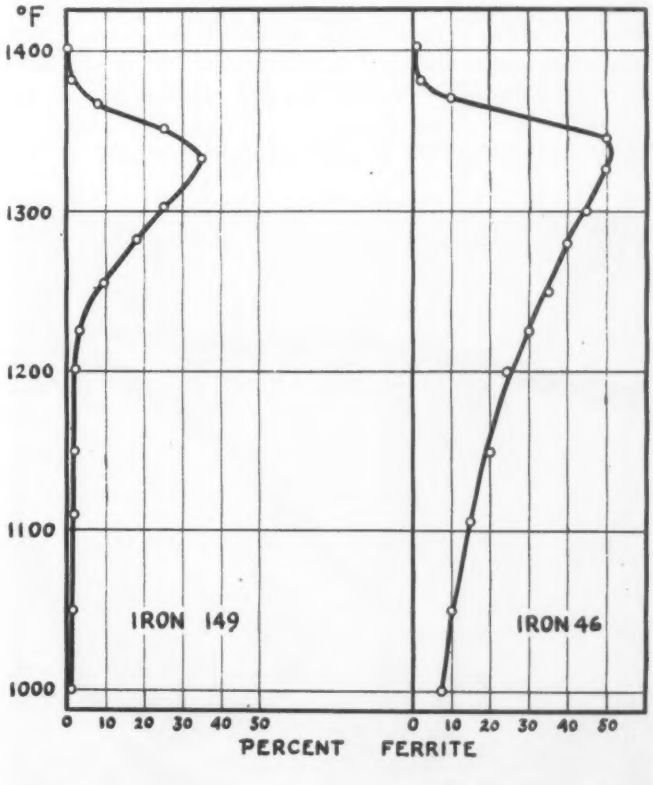
The effects of this mechanism are readily seen in malleable iron, which forms a "bull's eye" of ferrite around each nodule of graphite during transformation. Similar effects are found in the so-called graphitic steels, which contain substantial amounts of silicon. In gray iron, the ferrite forms as layers along the surfaces of the flakes, but the same principles apply.

Irons having type *D* graphite are liable to give much more primary ferrite than irons having type *A* graphite (see Figs. 9, 10, 11). In cases of mixed structure, where type *D* graphite occurs at the centers of the eutectoid cell pattern, primary ferrite will form as patches in these locations.

For this reason, irons having type *A* graphite are

Fig. 9—Amount of free ferrite formed in 5 min under conditions of isothermal treatment. Specimens were austenized at 1600. Iron 149 had type A graphite (see Fig. 10). Iron 46 had type D graphite (see Fig. 11). The small amount of ferrite formed at 1400 F simply means that transformation had not gotten underway in 5 min.[3]

Analysis of Irons	*T.C.*	*Si*	*S*	*P*	*Mn*
Iron 149 (Type A), per cent ...	*3.03*	*2.34*	*0.063*	*0.097*	*0.70*
Iron 46 (Type D), per cent ...	*2.93*	*2.19*	*0.064*	*0.093*	*0.76*



usually preferred for heat treatment. It is quite easy, however, to quench both types of iron to produce a fully martensitic matrix without any trace of free ferrite. Rapid cooling does not allow sufficient time for stable transformation to occur, and the austenite undercools to temperatures below 500 F and then transforms into martensite. In heavy sections, where the cooling rate at the center is insufficient to produce a fully martensitic condition, the foundryman resorts to the use of alloys, following the principles mentioned in the section on isothermal treatment.

Segregation in steel has been found to influence its transformation behavior on heating and cooling. If a steel bar is banded, due to segregation in the original ingot from which it was rolled, the rate of transformation will be different in different portions of the bar, as a result of differences in chemical composition. Similar effects of segregation are found in gray cast iron.

The segregation pattern in cast iron is different from that of steel because the mechanism of freezing is different. In cast iron, the major segregation effect occurs during the freezing of the eutectic and takes the form of a network which has been termed the cell structure. The boundaries of these cells represent the last portion of the eutectoid to freeze and, consequently, contain the highest concentration of segregated elements. Segregation of phosphorus into the cell boundaries is the most obvious thing noted in the structure. Molybdenum also tends to segregate along with the phosphorus.[5] In irons containing chromium, the chromium carbides tend to appear at the cell boundaries.

Effects of cell boundary segregation on transformation behavior have been noted by several investigators.[6, 7, 8] With moderately slow rates of cooling, the cell boundaries tend to follow the metastable transformation $(\gamma \rightarrow a + Ca)$, while the stable transformation $(\gamma \rightarrow a + Gr)$ is favored at the centers of the cells.

Fig. 10—Specimen of Iron 149, heated to 1600 F, quenched into a lead bath standing at 1250 F, held 30 sec. at 1250 F and finally quenched in water. "M" represents martensite, "F" is free ferrite, "P" is pearlite. Both stable and metastable transformations are going on at the same time. Free ferrite forms as small grains along surfaces of the graphite flakes. Etched. ×750.

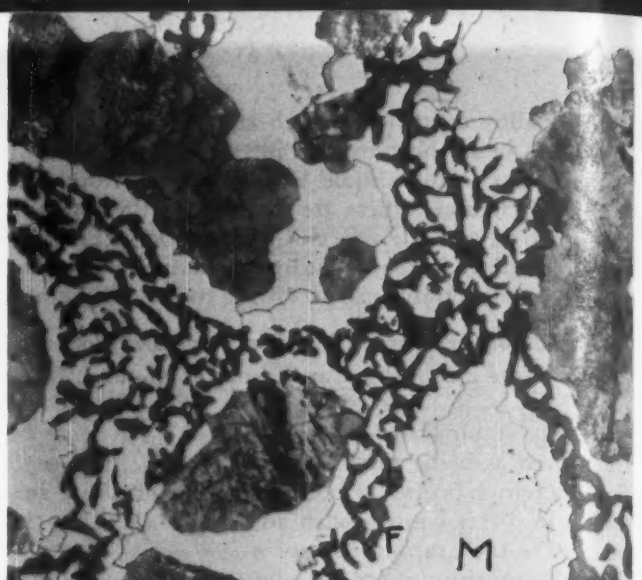


Fig. 11—Specimen of Iron 46 treated in exactly the same manner as that shown in Fig. 10. Note that the free ferrite is further developed than in Fig. 10. The small ferrite grains have consolidated into layers. There is some metastable transformation to pearlite, however, at points in direct contact with the surfaces of the graphite flakes. Etched. ×750.

Isothermal transformation in the temperature range from 1350 to 1200 F produces similar effects.[3]

At lower temperatures of isothermal treatment, the transformation is found to be more sluggish in the cell boundaries than elsewhere.[6] Under conditions of extremely fast heating and cooling, as by induction hardening, some untransformed austenite may be retained at the cell boundaries.[8]

All of these effects are natural consequences of differences in chemical composition at different points in the matrix. The cell structure must not be confused with the austenite grain size obtained on reheating above the transformation range. The cell structure is a segregation pattern formed during freezing and cannot be altered by recrystallization in the solid state. Control of the pattern goes back to the original casting and is carried out by inoculation of the molten iron before pouring.

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DESIGNING STRAINER CORES

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The author proposes seven standard shapes and sizes of strainer cores for the foundry industry. Strainer cores are employed to control discharge of metal from pouring basins or to regulate flow of metal in gating systems. The size and number of holes in a strainer core determine the rate at which metal will pass through the core under a given head of metal. Selection of a strainer core should be based on the required delivery rate of metal.

THE A.F.A. CORE TEST COMMITTEE has been making a study of the uses of strainer cores, with the ultimate purpose of proposing certain standard shapes and sizes for the foundry industry. When definite designs of strainer cores are generally adopted, the equipment needed to make these cores will be simplified. Pattern shops can then provide prints of the established dimensions on all pattern equipment. At jobbing foundries where large numbers of different patterns are received, strainer cores of standard sizes may be taken directly from stock and used without delay in production.

Strainer cores are employed to control the discharge of metal from pouring basins or to regulate the flow of metal in gating systems. If the stream of metal from a pouring ladle is not restricted, all non-metallic material is necessarily washed directly into the casting. By providing a restricted area in the gating system, any material lighter than the metal will be floated out and will not enter the cavity for the casting.

In the making of small molds, a strainer core is often placed near the bottom of each sprue. During the pouring of these molds the sprue is kept filled with metal so that any slag delivered with the metal will remain in the sprue. To aid in the pouring of large molds, a pouring basin is usually provided on each mold. By restricting the discharge of metal from the pouring basin, any slag from the ladle will be retained in the pouring basin.

Many designs of strainer cores are used regularly in the foundry. Although attempts have been made at some plants to simplify and standardize on strainer cores, no united effort has been made previously to

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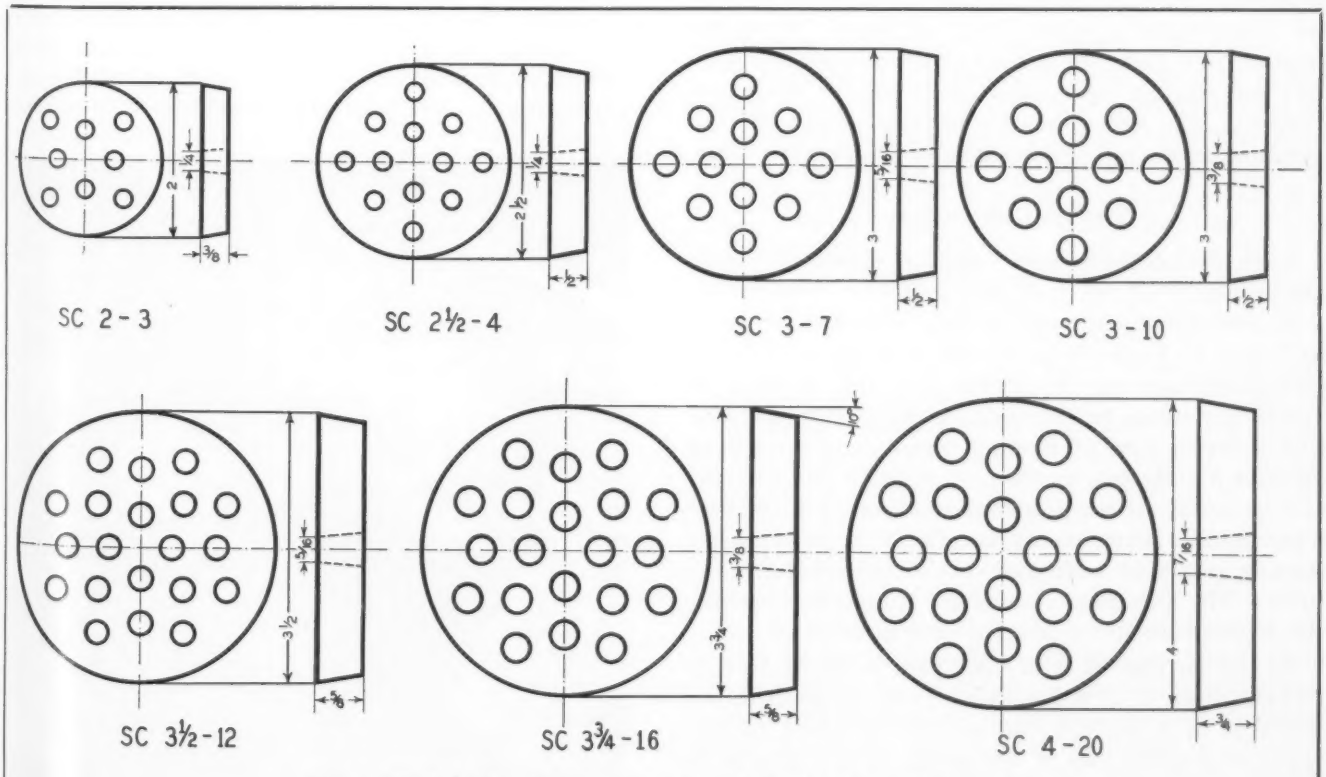

Fig. 1—Sketch showing seven proposed strainer core designs.

TABLE 1—STRAINER CORE DIMENSIONS

Designation	O.D., In.	Thickness, In.	Diameter Single Hole, In.	Number of Holes	Total Area of Holes, Sq. In.	Delivery* Lb/Sec
SC 2-3	2	3/8	1/4	8	0.39	3
SC 2½-4	2½	½	¼	12	0.59	4
SC 3-7	3	½	5/16	12	0.92	7
SC 3-10	3	½	3/8	12	1.32	10
SC 3½-12	3½	5/8	5/16	20	1.53	12
SC 3¾-16	3¾	5/8	3/8	20	2.21	16
SC 4-20	4	¾	7/16	20	3.01	20

* Delivery rate determined by trial with cast iron at 2700 F under a head of 2 in.

establish standard designs of strainer cores for the benefit of the entire industry.

When liquid metal comes in contact with an oil-sand core, the bonding material is destroyed by the heat from the metal, which causes a gradual disintegration of the core. As the conductivity of heat through the core is relatively low, this destructive effect progresses slowly. To withstand this effect of the heat, the sections of a strainer core must be of sufficient thickness to hold together until the required amount of metal has passed through it.

After examining many designs of strainer cores now in use, it was concluded that ¼ in. of core mixture between the holes was adequate for most applications. In other words, a strainer core should serve its purpose until ⅛ in. of the material around each hole is destroyed by the heat from the metal. Furthermore, the thickness of strainer cores should be based on the forces to which the cores are subjected. The larger the diameter, the greater should be the thickness.

The size and number of holes in a strainer core determine the rate at which metal will pass through the core under a given head of metal. Openings smaller than ¼ in. in diameter are usually not necessary for strainer cores used in molds for gray iron castings. The holes may be straight or tapered depending on the equipment used in making the cores.

Strainer Core Designs

Seven designs of strainer cores, as shown in Fig. 1, are proposed for the gray iron industry. The dimensions and delivery of metal through the cores are given in Table 1. Each design of core is designated by its maximum diameter in inches and the delivery of metal in pounds per second. In the development of this series of sizes of strainer cores, the plan was to provide a sufficient number of steps in the delivery rate to satisfy all requirements. At least ¼ in. of core material lies between any two holes in each design. Also, a sufficient width of core is provided for the print. The thickness of strainer cores was fixed on the basis of designs now used satisfactorily.

As the purpose of a strainer core is chiefly to control the amount of metal which passes through it, the selection of a strainer core should be based on the required delivery rate of the metal. If it is desired to pour 200 lb of cast iron in 20 sec, a strainer which will deliver 10 lb of metal per second will be needed.

The A.F.A. Core Test Committee wishes to obtain any suggestions which will aid in establishing the minimum number of designs of strainer cores.

Annual Meeting Of Electric Metal Makers Guild Scheduled For June

THE SIXTEENTH ANNUAL MEETING of the Electric Metal Makers Build, Inc., will be held at Bethlehem, Pa., June 16, 17 and 18, it is announced by Guild President R. H. Frank, who is also chairman of A.F.A.'s Central Ohio Chapter.

Featured among the papers to be delivered at the meeting are *"Fundamentals in Steel Melting"* by Dr. C. H. Herty, Jr., Bethlehem Steel Co., and *"Hydrogen and Nitrogen Contents of Steel"* by Dr. C. E. Sims, Battelle Memorial Institute.

The annual banquet of the Guild will be addressed by J. M. Sylvester, general manager of the Bethlehem plants of the Bethlehem Steel Co.

New Application For Fork Trucks

A NEW USE FOR FORK TRUCKS, recently developed by an Eastern foundry, makes it possible to dump castings into hoppers and chutes located several feet above floor level by means of truck-borne, dump-bottom hoppers.

The dump-hopper is basically a square metal skid bin, with the bottom hinged on one edge, and sides integral with the bottom bent up along the two sides of the bin. The degree to which the bottom can open is limited by chains secured to the bin sides and to the bent-up sides.

A hook, welded to the back of the bin, is used to hang the hopper from a notched member welded to the top of the truck. Hopper is dumped by hanging it from the notched member and then lowering the fork to release the hinged bottom, permitting control of material flow.

The fork truck picks up the loaded hopper, transports it to the dump area, and unloads the contents into processing equipment such as the tumbler illustrated.

SLAG CONTROL IS IMPORTANT IN CUPOLA OPERATION

This paper is the third of a series, dealing with modern cupola operation, sponsored by the Cupola Research Committee of A.F.A. Other papers will appear in future issues of American Foundryman.

PRESENT DAY TRENDS in the casting industry are toward higher quality castings. Every attempt is being made to cut scrap losses. Hence, more controls are being applied to both the cupola and molding procedures. The purpose of this paper is to stimulate interest in a cupola control that many foundrymen have overlooked or have not recognized as a control.

To foundrymen in general, slag is a necessary evil in cupola operation. The chief concern has been to obtain a slag sufficiently fluid to readily flow out of the cupola. Fundamental work in cupola slag research is lacking in the foundry industry and the work done to date is not sufficiently complete to enable the operator to make proper use of it.

To understand more fully the slag problem, the reasons for slagging will be considered. Slag is the result of the reaction between acid and basic compounds that enter the cupola in the charged material, or that are formed in the cupola. The ash from the coke used for melting, the oxides that adhere to the metal, sand that is charged into the cupola accidentally or otherwise, and the part of the cupola lining which is fluxed during the melting process must be separated and removed.

In addition, oxides of silicon, manganese and iron formed during melting must also be removed. Without fluxes the foregoing materials form a viscous, sticky slag which is difficult to handle. In this form the slag prevents the smooth downward flow of the charged materials and hinders the even distribution of the air in the melting zone. To increase fluidity, fluxes such as limestone and dolomite are used.

Flux Material Additions

It is interesting to note that, due to the meager knowledge of slag characteristics, only approximate quantities of limestone are recommended, such as: (1) The limestone charge usually is about 20 per cent of the coke charge by weight.[1] (2) The bed should be fluxed with three or four times the material added to each charge so that the bed coke will be promptly supplied with slag to hasten the establishment of normal melting conditions.[2] In all cases it is assumed that a slag of desirable characteristics will form, and that this slag will accomplish the necessary functions.

This assumption is erroneous for several reasons. First of all, the bed coke is not burned immediately after the blast is put on and little ash exists for slag making. Other slag forming materials in the charges are not in sufficient quantity to react with the excess lime in the cupola. The lime thus attacks the refractory lining to satisfy its desire to react with siliceous or other acid materials. The slag composition is in part a function of the temperature of formation in the cupola.[3] Second, the slag characteristic that probably governs the largest number of reactions in the cupola is the degree of slag viscosity.

A low viscosity slag allows the iron to absorb carbon, gives a clean drop, permits the proper distribution of air in the cupola, giving better combustion conditions, and causes little if any slag hole trouble. A highly fluid slag will coat the coke and metal droplets in thin layers. This type of slag also attains the highest superheat, thus further aiding fluidity. The tendency to entrap globules of iron as in a viscous slag is eliminated. Quantitative work along these lines is limited.[4]

Iron Oxide in Slag

Extremely acid or extremely basic slags are viscous in character. In addition, the extremely basic slags are sluggish at the higher temperatures. Large quantities of iron oxide increase the fluidity of high silica slags because iron oxide, an extremely basic compound, reacts with the silica to form another compound of high fluidity. Hence, a 50 per cent silica slag flows freely if sufficient iron oxide is present, but causes more erosion of the lining. Low lime slags that are high in silica are usually high in iron content.

It has been pointed out that "Enough has been written to disclose and to emphasize the fact that the ultimate modification of the composition of the molten iron is largely a result of careful or otherwise manipulation of the composition of the slag. Not only is the percentage of sulphur thus affected, but the degree to which the other oxidizable constituents are affected is determined." [5] Usually, basic oxidizing slags remove the most sulphur.

It has been shown that the absorption power of a slag is greater in the higher temperature range where the fluidity is also improved. Since sulphur absorption is governed by time of contact with the absorbing slag, a slag that is too thin will not have time to absorb it. This absorption, however, can be increased by increasing the volume of the slag. It has been shown that slags with silica contents of 35-40 per cent absorb twice as

much sulphur as slags that contain 50-55 per cent silica.[9]

Generally, silicon is oxidized from the metal charged and goes into the slag. However, in the presence of basic reducing slags silica can be reduced and picked up by the metal. The resulting metal contains a larger quantity of silicon than was calculated in the charged materials. The solution of the silicon in the metal prevents the desired carbon pick-up.

Slags Affect Grain Size

There are several statements in the literature regarding the effect of slags on the grain size of the iron. It is claimed by some that acid or silica slags tend to increase the austenitic grain size. On the other hand, it is indicated by others that the more basic the slag the more open the iron, and the more acid the slag the closer the iron.[11] It is interesting to note that the harder irons have been associated with straight limestone slags.[7] Here again, if sufficient knowledge of slag characteristics was available a control could perhaps be effected.

Basic oxidizing conditions are necessary for the removal of phosphorus. After the phosphorus is oxidized to the acid form, it reacts with the lime to give a tricalcium phosphate. A high lime slag aids this removal, but only in the presence of iron oxide. Slags containing more than 30 per cent silica will not take up phosphorus pentoxide.[9] A cupola melting good iron, however, does not have these conditions and no phosphorus absorption can be expected with good operation.

The effect of magnesia has been variously reported. Walls,[6] and Bancroft and Myers [7] have reported that magnesia improves fluidity. Sigerfoos and Womochel [8] report that dolomite when used in place of limestone does not improve cupola operating conditions as far as slagging is concerned.

It is found that cupola slags have higher melting temperatures as compared to blast furnace slags. The latter are run under strongly reducing conditions, while the former, when an acceptable grade of iron is being produced, are run under slightly reducing, neutral or slightly oxidizing conditions.

Various slag constituents affect the color of the slag. A high lime-magnesia slag has a gray or whitish appearance. Slags deficient in lime and magnesia are dark gray. A high iron-manganese slag is dead black, greenish or brown. Small amounts of iron oxide and sulphide give the slag a greenish tinge. Good slag is brittle, olive green in color with a white incrustation.

Analyses of slags with desirable characteristics are shown in Table 1. Full agreement among the analyses is lacking.

Apparently, investigations involving quantitative measurements of slag viscosities have not been extensive. It is believed that further work on slag viscosity would be an important approach to the slag problem.

Slag Color a Control Factor

A few foundrymen are using slag color as a criterion of their cupola operation. Oxidation of the molten iron by the use of excessive air can readily be detected, since the slag turns black. Analysis of the effluent gases will indicate the extent to which the air volume should be reduced. Large quantities of rusty scrap also make the slag black. In either case the iron oxide of the slag causes greater lining erosion.

Addition of silica sand, siliceous rock, or crushed cupola lining will increase the slag volume and decrease lining attack. An addition of 10 lb of the siliceous material is recommended per 40 lb of limestone. The amount, however, is not fixed and should be altered to obtain the desirable slag previously described. The addition of the siliceous material tends to bring the slag to equilibrium.

In one foundry carbon control is effected by slag control. During several heats, the total carbon was maintained within a four-point range. This was coupled with proper charging, maintenance of proper blast, etc., but it indicates that slag control is a great factor in cupola operation. Another foundryman reports that test bars and critical castings are not poured when the color of the slag is out of their working range.

TABLE 1—ANALYSES OF DESIRABLE CUPOLA SLAGS

Constituent	Percentages Reported		
	F. J. Walls [6]	J. W. Bolton[9]	Y. A. Dyer[10]
Silica	44.23	35-45	32
Alumina	13.43	5-25	15
Lime	31.72	—	38
Magnesia	4.84	—	—
Iron and Manganese Oxide	5.78	—	—
Lime and Magnesia	—	30-40	—
Iron Oxide	—	5-8	8
Manganese Oxide	—	1-4	2.5
Sulphur	—	0.5 or under	—
Calcium Sulphide	—	—	3
Alkalies	—	—	1.5

Since slag reactions are of considerable importance in gray iron melting, it is important to the industry to obtain more information concerning them. The Cupola Research Committee would appreciate receiving comments from the industry on this subject.

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VARIABLE PROPERTIES FOUND IN WESTERN BENTONITES

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FOUNDRY PERSONNEL responsible for compounding the sand mixtures must recognize and allow for variable properties in the raw materials used. Unfortunately, the extent of the variations are not all known, and their influence on the prepared sand is not easily traced to the origin of the material. This discussion covers some variables found in western bentonites.

Over a period of several years, variations in the properties of green molding sand, compounded of washed and dried silica sand, western bentonite, corn cereal and water have been investigated by the writer. Communicated information (about 1940) from another source * pointed out noticeable variations in air and oven dry strengths of bentonite bonded sands.

While there were indications that the western bentonite was not uniform from shipment to shipment, the sources of supply pointed out the uniformity in mining and processing, and illustrated the uniformity of the material by known laboratory tests such as Stormer viscosity, pH, screen analysis, moisture analysis, petrographic examination, thermal analysis and actual physical properties on sand-bentonite mixtures. While producers defended by tests the uniformity of their products, the writer experienced difficulties with occasional shipments.

Experience in the writer's plant had shown that high green deformation and high dry air strength were conducive to the production of castings with fewer sand defects. Considerable effort was expended to acquire the maximum of both of these properties compatible with other properties developed at the same time.

Molder's "Hand" Test

Deformation tests were often erratic, a more satisfactory test being that of hand feel or squeeze, known to every molder. No laboratory test of deformation yet devised can substitute for the feel of the hand. When sands reported by the molders as being brittle and crumbly were used, there was a noticeable increase in dirty castings (included sand). The so-called brittle sand appeared to be drier at normal moisture levels and crumbled under the molders tools.

During 1946 two shipments of bentonite from different producers were being used simultaneously. Bentonite from producer "A" gave a satisfactory sand mixture, while bentonite from producer "B" resulted in an unsatisfactory sand mixture. After several days of alternate testing in the shop it was concluded that bentonites "A" and "B" were outstandingly different. On the occasions of alternate usage the molders were always correct in their identifications of the satisfactory and unsatisfactory bentonites.

Laboratory tests showed sands bonded with bentonite "B" to be 20 per cent higher in green compression strength, but 25 per cent less in deformation, and as much as 40 per cent less in compression strength after air drying as compared to sands bonded with equivalent amounts of bentonite "A."

Various factors were investigated in an attempt to improve bentonite "B" bonded sands. Over a period of time the following conclusions were drawn: (1) Higher moisture improved "B" sands; (2) acids harmed while alkali improved both "A" and "B" sands; (3) longer and harder mulling improved "B" sands; (4) increased amounts of cereal improved "B" sands.

With the aid of higher moisture contents, increased cereal, longer mulling and added alkali, the "B" sand mixtures were made usable and met with fewer objections from the molders.

Bentonite Wetting Rates

While attempting the hopeless task of microscopic differentiation between the "A" and "B" bentonites, it was discovered, quite by accident, that "A" and "B" wetted in water at different rates. This was the first test that demonstrated a difference between the as-received bentonites. Bentonite "B," when floated on water, wetted at an appreciably more rapid rate than did "A." Various other samples of bentonite were secured from neighboring foundries. Correlation between wetting rate and mulled sand properties of the various samples was attempted.

The wetting test proved to be quite satisfactory in predetermining the probable quality of the bentonite. However, no truly quantitative test other than a comparative one was worked out. By floating two samples of bentonite simultaneously and side by side, differences in wetting characteristics were quite apparent. The faster wetting and generally more flocculated bentonite always gave sand of higher green strength, lower deformation and air dry strength.

Additions of almost any matter to either the bentonite or the water markedly altered the wetting rate. This was strikingly shown when either an alkali or an

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acid was added to the water. Mixing cereal with the bentonite prior to placement on the water showed a marked effect.

Table 1 shows the results of comparative wetting of 32 different shipments of bentonites from ten different foundries supplied by six different producers. The as-received moisture and wet particle size is also reported. Bentonites from the same producers are listed consecutively to show variations in materials received from the same source.

Tests on sands produced from these bentonites showed good, fair, poor and quite poor deformations in relation to the time required to wet. Good deformation was secured where the relative wetting time was greater than 35 sec, fair from 22 to 35 sec, poor from 18 to 22 sec, and quite poor under 18 sec. Green strength, however, was the reverse, being higher for the rapid-wetting bentonites. If green strength alone was sought, then the good bentonites would be considered poor, and the poor would be good.

Because the rapid-wetting bentonites were frequently lower in moisture than the slower-wetting bentonites, samples of both rapid-wetting and slow-wetting bentonites were dried to constant weight and retested by wetting. Drying was accomplished at 110 C for 2 hr. After drying to a constant weight, both bentonites were found to have the same wetting rate they had previous to the drying.

To determine the effect of temperature, sample No. 28, which was noticeably slow in wetting, was dried for 2 hr at the various temperatures shown in Table 2.

TABLE 1—COMPARATIVE WETTING TESTS

Sample No.	Source		Moisture As Recd., %	Time to Wet, sec	Type Particle, Wet
	Producer	Foundry			
1	C	a	6.0	20	medium
4	C	c	5.3	12	coarse
8	C	e	1.7	15	medium
9	C	c	3.3	8	very coarse
10	C	f	1.1	22	medium
13	C	h	7.0	15	coarse
15	C	h	6.6	12	very coarse
17	C	h	6.6	12	very coarse
31	C	c	6.0	30	fine
12	D	b	4.2	17	coarse
14	D	i	5.0	12	coarse
16	D	i	11.1	60+	very fine
18	D	j	4.1	18	coarse
20	D	i	6.1	10	very coarse
21	D	i	6.2	18	coarse
24	D	i	2.6	8	very coarse
27	D	i	13.3	45	fine
32	D	c	5.5	20	coarse
19	F	i	11.1	40	fine
22	F	i	10.8	45	fine
23	F	i	8.7	20	fine
25	F	i	8.2	35	fine
26	F	i	6.6	20	medium
28	F	i	7.5	60+	very fine
29	F	i	5.5	35	fine
33	F	?	8.2	55	very fine
3	G	b	5.5	22	medium
11	G	g	2.2	15	coarse
2	H	b	4.5	28	medium
5	H	b	4.3	25	medium
6	H	b	3.0	10	very coarse
7	J	d	3.2	12	coarse
32	southern bentonite		5.1	less than 1	

TABLE 2—EFFECT OF DRYING TEMPERATURE, SAMPLE NO. 28

Temperature, C	Time, hr	Wet Rate, sec	Moisture Removed, per cent
As recd.	—	60+	—
110	2	60+	7.5
300	2	60+	7.5
350	2	10	7.9
400	2	2	8.0
500	2	2	8.2

When portions of sample No. 28, dried at 110 C, were mixed with portions dried at 500 C various wetting rates were secured. As more of the sample dried at 500 C was added, the mixture wetted more rapidly.

Conclusions drawn from the work are as follows:

1. While quantitative values of an exact nature are lacking, there is ample evidence that various shipments of bentonite as received are not the same physically.
2. There was no indication that selection of a producer will assure consistent bentonite.
3. Moisture contents as received varied from 1.1 to 13.3 per cent, with no evidence to indicate that the percentage of contained moisture had any bearing on the physical variations sought in this report.
4. Use of the pH test in control of the sand is probably advantageous.
5. Bentonite will lose or gain moisture on exposure to air without heating.
6. Higher green strength sand is obtained with rapid-wetting bentonite.
7. Lower deformation sand is obtained with rapid-wetting bentonite.
8. Lower dry strength sand is obtained with rapid-wetting bentonite.
9. Wetting rate is altered by almost any addition to the bentonite or water.
10. Process drying of the bentonite by the producer should be conducted in such a manner that no part of the bentonite is heated above 300 C.

Further study of this problem and this method of testing is solicited from any one interested. The objectives should be:

1. Quantitatively exact method of evaluating the wetting test.
2. Quantitatively exact method of registering the hand feel of sand.
3. Correlation of (1) and (2).

Battelle Memorial Institute Houses Unpublished Metallurgical Works

A large number of rare and unpublished bibliographies on metallurgical and foundry practices have been added to the library of the Battelle Memorial Institute, Columbus, O., and are now available on loan to industrial organizations.

The bibliographies were compiled by technical librarians affiliated with the Special Libraries Association, and include, among other scientific and technical subjects, papers on metallurgy and centrifugal casting (1910-1942).

A complete listing of the bibliographies may be obtained by writing Ralph H. Hopp, technical librarian, Battelle Memorial Institute, Columbus, O.

Conclusion of the report of the Ohio Regional Foundry Conference held in Cleveland, March 11 and 12. The first part of the story appeared in the April issue of *American Foundryman*, pages 153-156.

REGIONAL FOUNDRY CONFERENCE

First Ohio Regional Meet Successful

COLD CRACKS OR STRAIN CRACKS occur at low temperatures but are caused by conditions which existed at high temperatures according to B. C. Yearley, assistant manager, National Malleable & Steel Castings Co., Cicero, Ill., in his talk *"Cracks in Ferrous Castings—Their Causes and Remedies."*

The speaker followed this statement with a review of standard design features which often lead to cold cracks, such as wheels with heavy hubs and rims, light-and-heavy section castings, etc. Frequent occurrence of high tensile stresses in the heavy sections of castings (the last sections to freeze) was brought out.

Major causes of cold cracks cited were: 1. Lack of dimensional stability, often due to uneven cooling at higher temperatures. 2. Low ductility at or near room temperature. The remedy for cold cracks is to produce castings which are dimensionally stable at 1100 F. Then no deformation would be required in the range where there is no ductility.

Stress relieving at 1300 F to allow castings to adjust to zero stress is a satisfactory remedy to cold cracking. Slow cooling is not essential, Mr. Yearley said, adding that air cooling was safe. He added a word of warning that improper stress relieving may intensify stresses in some members of castings.

"Effect of Boron on Malleablization of White Iron," presented by Joseph Micksch and H. A. Fabert, students at Case Institute of Technology, will appear soon in AMERICAN FOUNDRYMAN. A summary of the paper prepared by the authors follows.

To effect such a study, a series of boron white irons, varying from 0.0005 to 0.05 per cent boron, were prepared by the addition of a 1 per cent boron master alloy. The white iron test bars were annealed and the resulting microstructures were studied.

Time at the upper critical varied from two to 88 hours at 1700 F. The lower critical treatment for all bars was the same.

A study of the resulting microstructures showed the following:

1. Irrespective of boron content the fineness of the anneal appeared to increase, then decrease with increasing boron.

2. The amount of retained pearlite, due to the short aneal, appeared to increase, then decrease with increasing boron.

3. Boron above 0.003 per cent refined the ferrite grain and graphite particle size.

4. At approximately 0.003 per cent boron a complex carbide began to appear, the amount increasing with increasing boron.

"Modernization and Malleable Melting Practice," a discussion of continuous melting and malleable duplexing, was presented at the third malleable iron session by W. R. Jaeschke, Whiting Corp., Harvey, Ill.

Explaining that the cupola is the only truly continuous melting unit in commercial use in foundries, and that the air furnace is a batch type furnace, the speaker told how the two are combined to take advantage of the best features of both. The cupola provides high speed melting while the air furnace provides an iron relatively low in carbon and suitable for the higher grades of malleable castings.

Reviewing early attempts to duplex from cupola to electric furnace, and the beginning of cupola-air furnace duplexing, Mr. Jaeschke discussed carbon reduc-

H. F. Scobie, American Foundrymen's Association, Chicago (starting left), F. W. Fuller, National Engineering Co., Columbus, O., F. C. Cech, Cleveland Trade School, and F. J. Pfarr, Lake City Malleable Co., Cleveland.

(Photographs courtesy of Sterling Farmer, Sand Products Corp.)

Prof. G. M. Cover, Case Institute of Technology (left) and Walter Bonsack, Apex Smelting Co., of Cleveland.

Left to right, Peter Rettig, Rettig Pattern Works, Carl Winkler, Standard Pattern Works, both of Cleveland, and Ladd Salach, Plastic Corp., Chicago.

tion. In cupola-air furnace melting, carbon reduction is a function of time, temperature, and furnace atmosphere. Most duplexing units are fired by pulverized coal, he said.

Duplex units can be obtained in sizes from four to 20½ tons per hour. Multiple units are preferred to single units capable of handling more than 20½ tons per hour, while units able to melt less than four tons per hour are too costly to operate economically.

Cupola Melting Control

Mechanical charging was recommended by the speaker and hot blast equipment was suggested for heavy tonnages. Fuel savings of 15 per cent or more and better control over melting were cited as advantages of hot blast operation. Dry blast equipment was suggested as a means of avoiding casting losses which result from variations in humidity. Front slagging spouts were recommended for duplex melting cupolas.

For the air furnace, Mr. Jaeschke prefers a unit pulverizer and preheated air. The unit pulverizer gives flexibility in control of coal fineness while preheated air improves combustion, reduces fuel costs and helps dry the coal in the pulverizer. In discussing control, he mentioned the standard sprue fracture test, chemical analysis, temperature measurement, and gas analysis. Control should start with the raw materials, according to Mr. Jaeschke.

A preheating fire should be started in the air furnace just before lighting the cupola; for a cold furnace allow an additional hour. Slow firing heats the brick uniformly without overheating the brick face. It is well to increase the firing rate when the first metal is tapped into the air furnace. Within half an hour the firing rate should be up to usual operating maximum, Mr. Jaeschke concluded.

Educational Session Features Preselection Testing

A general session on education was held the afternoon of March 11 under the chairmanship of F. C. Cech, head, patternmaking division, Cleveland Trade School, and George K. Dreher, executive director, Foundry Educational Foundation, Cleveland. The session started with *"Preselection Testing of Foundry Personnel"* by Prof. Eleroy L. Stromberg, head, psychology department, Cleveland College. He explained that an approach to the selection of three levels or grades of foundry personnel has been attempted through the addition of standardized tests to the already functioning selection system. These three levels are widely different and can be called (1) the labor grade level, (2) the semi-skilled and skilled labor level, and (3) the foreman level.

No selection system can be effective unless it is designed to meet the specific need of the local industry. Care must therefore be taken not to accept selection devices which are useful in other foundries until they have been proved to be valid in the local situation. Effective testing at the labor grade level is accomplished by an evaluation of the personal history and experience of the successful worker as contrasted with the unsuccessful worker, according to Prof. Stromberg.

At the skilled and semi-skilled level there are specific abilities which relate to success and the procedure is somewhat complex. The "testing" of the measuring device within the organization assumes great importance.

In selecting supervisors or foremen, a battery of tests and a specific interview prove to be of great value. It is apparent then, said the speaker, that no one test is the key to foundry selection program, but that a carefully planned program which is also carefully executed is necessary.

Foundries would profit if the money spent in replacing poorly selected men were spent in carefully evaluating the applicant before hiring. Present research in the selection of foundry personnel indicates that aid can be given at all levels by qualified workers in the area of personnel selection, concluded Prof. Stromberg.

J. G. Goldie, general superintendent, M.B.M. Foundry Inc., Cleveland, presented a paper on a subject on which he is an authority and in which he has long been interested—apprentice training. He explained the need for and the place of various types of training. Strongly favoring a full-length apprenticeship, he said that every shop should have at least one apprentice. Mr. Goldie's paper, *"Apprenticeship, Short Term Training, or Both,"* will appear soon in AMERICAN FOUNDRYMAN.

Stresses Basic Engineering Education

In his talk, *"What the University Contributes to Foundry Industrial Training,"* Prof. K. H. Donaldson, head, department of metallurgical engineering, Case Institute of Technology, described and recommended a standard basic engineering course and included the humanities. Pointing out that a graduate is far from a finished foundryman, he suggested specialized training in a graduate school.

According to Prof. Donaldson, faculty members should spend half their time on development and re-

search. This increases their ability and stimulates interest, and gives students who help them a chance for development.

Mr. Dreher concluded the educational session with a talk on the work of the Foundry Educational Foundation. He estimated the need for engineering graduates to fill managerial positions in the foundry industry at 1000 annually. The FEF program at six engineering schools, Cornell, Massachusetts Institute of Technology, University of Wisconsin, Case, University of Cincinnati, and Northwestern University—is expected to provide directly some of the men needed and to interest others in a foundry career.

Reviews Recent Steel Metallurgy Advances

Dr. C. H. Lorig, assistant director, Battelle Memorial Institute, Columbus, Ohio, spoke on recent metallurgical developments at a steel session, devoting his remarks to melting, steel casting metallurgy, heat treatment, and high temperature alloys. Oxygen content of the metal is independent of slag composition, according to recent investigations, said Dr. Lorig. Prolonged holding under a reducing slag merely to lower the FeO content of the metal without a change in carbon may be considered a waste of furnace time. Long holding of a quiet bath under strongly basic slags in basic furnace practice to remove sulfur is wasteful of time, for better and more rapid desulfurization is obtainable if the slag and metal are in more intimate contact as a result of mechanical stirring or a boil.

Perhaps the most discussed development in steel melting practice in the past few years, according to the speaker, has been the use of pure oxygen for reducing melt-down and decarburization times. The most effective use in the open hearth is to direct the oxygen stream against the solid metal after it has been heated to about 2000 F. There is no noticeable loss in metal since the iron oxide formed is later reduced during the refining period.

Introduce Oxygen Into Molten Bath

Decarburization time has been reduced by introducing oxygen into the molten bath. At a high carbon level, the efficiency of oxygen is very high, with less than the theoretical amount necessary to oxidize the carbon to carbon monoxide. This is the result of the violent boil which accelerates normal reactions and explains why air is almost as effective as oxygen for shortening decarburization time.

Extensive research indicates that long oxidation heats with no block give superior mechanical properties. This leads to the conclusion that no advantage is gained by early furnace deoxidation. As a result of this work by Carter and Donoho, the following furnace practice to obtain high tensile quality was suggested: (1) keep the melt-down at least slightly oxidizing to minimize the possibility of gas absorption; (2) establish a high concentration of FeO to lower the residual manganese and silicon and to reduce the solubility of gases; (3) provide melt-down carbon high enough to permit a considerable carbon drop to obtain a vigorous boil so as to flush out all gases and inclusions and prevent atmospheric gases from re-entering the bath; (4) do not try to force the carbon on ore-down to too low a value; (5) maintain the slag moderately oxidizing and the heat open so long as practical while the carbon is being adjusted and the slag is put in shape.

Ohio Regional Foundry Conference Chairman Elmer C. Zirzow, National Malelable & Steel Castings Co., Cleveland, (starting left), Prof. K. H. Donaldson, Case Institute of Technology, and Northeastern Ohio Chapter Chairman Howard C. Gollmar, Elyria Foundry Division, Industrial Brownhoist Corp., Elyria, Ohio.

J. G. Goldie, M.B.M. Foundry Co. Inc. (starting left), E. T. Kindt, Jr., Kindt-Collins Co., and V. J. Sedlon, Master Pattern Co., all of Cleveland.

T. D. West, West Steel Casting Co., Cleveland (left to right), H. A. Fabert and Joseph Micksch, students, Case Institute of Technology, and President T. Keith Glennan of Case.

High hydrocarbon content is frequently responsible for inferior quality and nitrogen has a great effect on metal soundness. Both may be controlled by a vigorous boil, nitrogen removal being facilitated by decarburization with pure oxygen. A flushing process using dry nitrogen or argon is expected to find usage in foundries to minimize casting rejects caused by porosity. Although aluminum deoxidation has been successful in controlling pinholes, the aluminum causes graphitization in some castings on long exposure to high temperatures. Silicon steels with chromium added have been advocated for steam lines and high-temperature service, but it has not been proven that these steels do not graphitize on long exposure to temperatures in the range of 900-1100 F.

The important influence of complex sulfide inclusions upon toughness of cast steel is now well known, said Dr. Lorig. However, the toughness of steel, which is reasonably sound and free from segregations of non-

metallic inclusions, is largely dependent upon the carbides. Heat treatment is required to take full advantage of the inherent properties of cast steel. Recent work indicates that the long high-temperature homogenization treatments do not improve the mechanical properties and hardenability enough to justify their cost and time.

The problem of obtaining the best strength is not solved merely by selecting a steel with sufficient hardenability. Steels with very high hardenability may crack in quenching or may be dimensionally unstable. Heat treatment will be relied upon more and more to effect weight reductions and to take full advantage of the optimum properties of cast steels.

The importance of grain distribution was brought out in the third steel session by C. A. Sanders, engineer, American Colloid Co., Chicago. His paper, *"Controlling Sand Grain Distribution Reduces Steel Foundry Costs,"* appeared in the April issue of AMERICAN FOUNDRYMAN, pages 142-146.

Aluminum Alloys Cast in All Ways

Walter Bonsack, director of laboratories, Apex Smelting and Refining Co., Cleveland, and Walter J. Klayer, works manager, Aluminum Industries, Inc., Cincinnati, presided over the first non-ferrous session at which the speaker was Walter E. Sicha, assistant chief, Aluminum Research Laboratories, Aluminum Co. of America, Cleveland. Aluminum alloy castings are made primarily by the sand, permanent mold, and die casting processes, said Mr. Sicha, in his talk, *"Commercial Aluminum Casting Alloys,"* with small quantities being made by plaster molding, precision investment casting, and slush casting.

Markedly superior mechanical properties and casting characteristics are obtained by alloying, although commercially pure aluminum castings are used in the rotors for some types of electric motors. Many of the alloys were developed specifically for a single casting process. Alloys are available for use in the as-cast condition and for heat treatment. Aluminum alloys containing copper, silicon, magnesium, and zinc, used singly and in combination, were discussed. Detailed descriptions of composition, outstanding characteristics, and uses were presented. Mr. Sicha showed slides illustrating aluminum alloy castings representing familiar and new applications.

Recommends Oxidizing Melting Atmosphere

"Brass and Bronze Foundry Practice," by H. L. Smith, chief metallurgist, Federated Metals Division of American Smelting & Refining Co., Pittsburgh, was the topic at the session under the direction of Mr. Bonsack, and C. F. Bunting, foundry metallurgist, Pitcairn Co., Barberton, Ohio. Concentrating on melting practice, Mr. Smith pointed out that water vapor, hydrogen, oxygen, and carbon produce casting porosity. This can be minimized by melting with a slightly oxidizing flame followed by reduction. The cold zinc test for a reducing flame, and deoxidation with zinc or phosphor copper, were described. Degassed metal shrinks more than a metal of higher gas content, warned Mr. Smith, therefore larger risers are generally necessary.

At the third non-ferrous session, J. W. Cable, Induction Heating Corp., New York, spoke on electronic core baking. Mr. Bonsack and G. N. Wright, John Harsch Bronze & Foundry Co., were chairmen. Cores baked in as little as 40 seconds were reported by Mr. Cable, who explained that a rapidly alternating electrical field caused the core to heat uniformly throughout. In the oven method cores start baking on the outside. Plastic binders not suited to usual methods of core baking had to be developed.

V. J. Sedlon, president, Master Pattern Co., Cleveland, acted as chairman for the three pattern sessions with F. C. Cech; Peter Rettig, owner, Rettig Pattern Works, and Carl Winkler, general manager, Standard Pattern Works, acting as discussion leaders of the first, second, and third sessions, respectively. Morris Bean, president, Morris Bean Co., Yellow Springs, Ohio, talked on gypsum bonded molds at the first session.

Plaster Molds Make Accurate Boxes and Driers

Tracing the origin of plaster molds back to 4000 B.C., Mr. Bean explained the lost wax process and discussed materials currently being used in special molding methods. He covered the use of gypsum, ethyl silicate, and filler such as asbestos fiber. Hardwood patterns with a waterproof coating may be used in plaster molding, said Mr. Bean, but for long runs a metal pattern should be used.

Highly accurate core boxes and core driers can be made in plaster molds. Tolerances of plus or minus 0.001 in. are possible in plaster molded castings, closer tolerances being easier to achieve on simple small patterns than on larger or more complex ones, according to Mr. Bean. During the question period, he explained that blowing around inserts was prevented by heating to about 600 F and storing in a moisture proof cabinet until ready to place in the mold.

Claims Patternmakers Not Progressive

At the second pattern session, Ernest Kindt, Jr., Kindt-Collins Co., Cleveland, gave a talk entitled *"Patternmaking—Past, Present, and Future."* Pointing out that a patternmaker must be a good businessman and a good salesman, in addition to being a good craftsman, he criticized the patternmaking phase of the foundry industry for its unwillingness to try more new methods and new products . Substitutes for pattern wood should be sought because the shortage may never improve, he said. Mr. Kindt suggested a testing bureau for testing and evaluating new products as a way to introduce new materials and to achieve standardization.

"Plastics as Used in Patternmaking," by Ladd Salach, president, Plastic Corp., Chicago, concluded the round of pattern sessions. Plastic patterns will withstand the treatment other patterns receive and in addition they have an especially smooth surface which makes for easy drawing, he said.

The speaker explained the use of phenolic-type plastics, catalysts, fillers, and plaster molds for the production of plastic patterns and matchplates. Sand and plastic materials may also be used for the molds. Core boxes of plastic are in use and giving satisfactory service, according to Mr. Salach. He illustrated his talk with coreboxes and match plates and with a movie which showed them in actual foundry use.

Plastic patterns are easily machined, preferably with carbide tools, and patches, additions, and fillets may easily be added. Casting of plastic pattern sections less than $\frac{3}{16}$ in. was not recommended.

EXPLAIN USES AND ADVANTAGES OF CASTINGS

USES AND ADVANTAGES OF CAST METALS were discussed at the A.F.A. Chicago Chapter-sponsored sessions of the 1948 Chicago Technical Conference. Four speakers appeared at two sessions under the general chairmanship of Fred B. Skeates, foundry superintendent, Link-Belt Co., Chicago, who is president of the Chicago Chapter, to explain which cast metals should be used under a variety of service conditions. The sessions were intended primarily for design engineers, architects, and users of castings.

A. W. Gregg, executive engineer, Whiting Corp., Harvey, Ill., presided over the first session at which the speakers were H. L. Smith, chief metallurgist, Federated Metals Division of American Smelting & Refining Co., Pittsburgh, and E. B. Sherwin, president, Chicago Hardware Foundry Co., North Chicago. R. D. Phelps, Jr., secretary, Frances & Nygren Foundry Co., Chicago, acted as technical moderator for Mr. Sherwin who spoke on gray iron castings. Mr. Smith talked on non-ferrous alloy castings.

Cites Increased Use of Aluminum Alloys

Covering aluminum alloys, copper-base alloys, and white metals, Mr. Smith explained that the increasingly wide-spread use of aluminum casting alloys was due to increased availability and a continued lowering in cost. Aluminum alloys, he said, have a wide range of mechanical and chemical properties. Lightness is particularly outstanding and enables engineers to make marked reductions in dead weight and inertia.

Aluminum casting alloys can be obtained in a wide range of yield strength and ductility, and with tensile strength ranging from 12,000 to 45,000 psi. Noted for resistance to corrosion, these alloys can be given a variety of finishes, including dyeing. Most of the common metals can be electroplated onto aluminum and we may soon be able to plate chromium as well, said Mr. Smith. The high heat and electrical conductivity of aluminum is difficult to reduce as compared with copper, he added.

In substituting aluminum alloy castings for parts produced by other processes, or for other types of castings, one must be specific regarding which aluminum alloy is to be used, Mr. Smith warned, because all aluminum alloys are not alike in properties.

Brass and Bronze Castings Readily Obtained

In discussing the copper-base alloys, Mr. Smith said that no other group of alloys offers such a wide variety of combinations of properties to architects and engineers. Moreover, he pointed out, castings can be readily obtained from brass and bronze foundries. Less than 20 years ago there was considerable confusion regarding selection of copper-base alloys because there were over 600 in use. Now about 25 alloys adequately provide for needs in cast brass and bronze.

Silicon bronzes are replacing tin bronzes more and more, because of the tin shortage. Silicon is two to three times as effective as tin, according to Mr. Smith, and the silicon bronzes easily match the tin bronzes in properties. Corrosion resistance of silicon bronzes is very good.

The white metals may be classified as bearing metals, solders, and type metals. Replacement of costly high tin alloys with lead alloys has resulted in a better bearing with superior fatigue strength, according to the speaker. Five or six bearing alloys cover the entire range of industrial needs and simplify the work of the designer and maintenance man.

Stress Special Qualities of Gray Iron

Approaching the uses and advantages of gray iron from the standpoint of the various properties of the material, Mr. Sherwin stressed these qualities: excellent castability, good machinability, good wear resistance, high damping capacity, high compressive strength, and high resistance to notch effect. In discussing casting design, the importance of cooperation between the designer and foundryman was brought out.

Attention was called to the value of relying on specialists for the production of certain types of irons, but Mr. Sherwin made that point that any reputable foundryman can reproduce or duplicate most specification irons, whether produced under trade names or not. Under most circumstances the designers should determine the properties desired and leave the chemical analysis of the iron to the foundryman who will know best how to meet the specifications.

Prefers Simulated Service Tests

C. V. Nass, vice-president, Beardsley & Piper Co., Chicago, was technical chairman of the second session, substituting for John A. Rassenfoss, research metallurgist, American Steel Foundries.

E. W. Gauslein, research metallurgist for the same organization, gave Mr. Rassenfoss' paper on uses and advantages of steel castings. The paper, which appeared in the December, 1947, issue of AMERICAN FOUNDRYMAN under the title *"Steel Castings—Uses as Engineering Materials,"* brought out the wide range of steel casting uses and showed that simulated service tests are more valuable than tests performed on standard test specimens.

J. H. Lansing, consulting engineer, Malleable Founders' Society, Cleveland, and C. F. Lauenstein, chief metallurgist, Link-Belt Co., Indianapolis, were speaker and moderator, respectively, for the malleable phase of the sessions. Mr. Lansing discussed the standard and the pearlitic malleable irons and pointed out the recognition these materials received during the war when they were called on to substitute for forgings and parts made in other ways.

Uses and Advantages of Castings

Full length papers on uses and advantages of castings, which have appeared recently in AMERICAN FOUNDRYMAN, are:

"Economics of Castings Use," Everett Laitala, March 1948, pages 48-51.

"Engineering for Aluminum Alloy Castings," T. R. Gauthier and H. J. Rowe, February 1948, pages 27-36.

"Magnesium Castings Production and Use," A. W. Winston and M. E. Brooks, January 1948, pages 30-36.

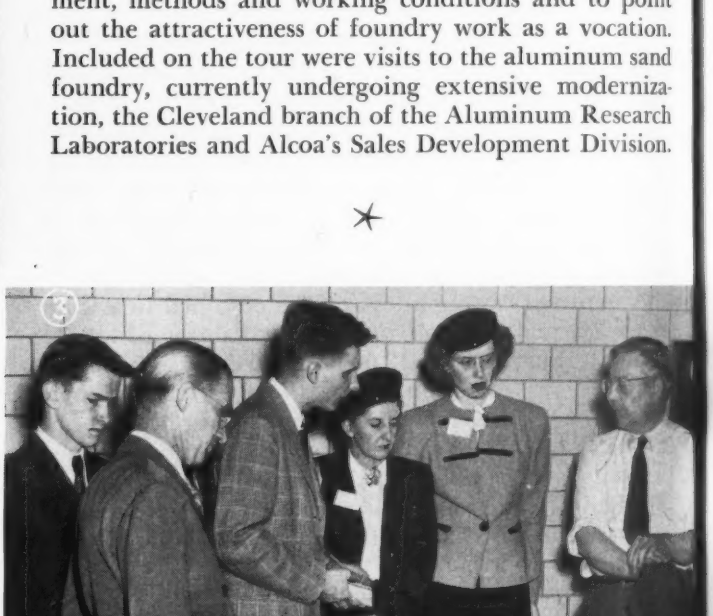
"Steel Castings—Uses as Engineering Materials," John A. Rassenfoss, December 1947, pages 38-44.

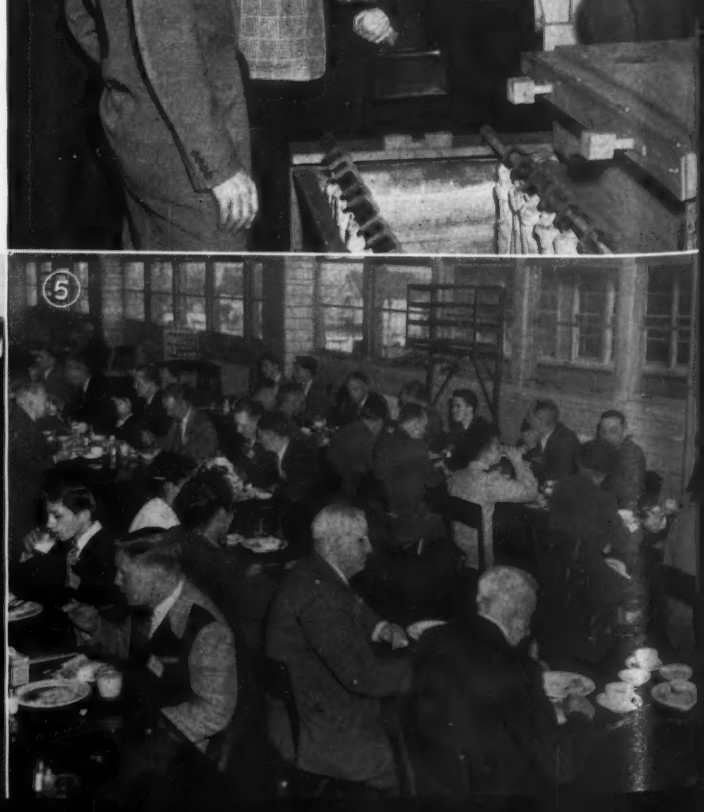
SCHOOL GROUPS VISIT A MODERN ALUMINUM FOUNDRY

Students, vocational guidance counsellors and foundry teachers representing some 25 senior and junior high schools in the Cleveland area were recently given an opportunity to inspect the Aluminum Company of America's Cleveland Works.

Sponsored by the Northeastern Ohio Chapter, A.F.A., the visitation was designed to acquaint students and educators with the latest advances in foundry equipment, methods and working conditions and to point out the attractiveness of foundry work as a vocation. Included on the tour were visits to the aluminum sand foundry, currently undergoing extensive modernization, the Cleveland branch of the Aluminum Research Laboratories and Alcoa's Sales Development Division.

Fig. 1—C. M. Tucker, head of the Radiographic Laboratory shows examples of cast aluminum bearings to visiting teachers, students and A.F.A. representatives. Fig. 2—Operation of a tensile testing machine is demonstrated by M. W. Daugherty, assistant laboratory manager. Fig. 3—Clarence Dumont, chief of Alcoa's Aluminum Research Laboratories, demonstrates electrolytic finishing processes. Fig. 4—E. E. Stonebrook, metallurgist, discusses physical testing methods. Fig. 5—Part of the visiting group and A.F.A. representatives lunching in plant.





WHO'S WHO

H. L. Campbell

H. L. Campbell (*"Strainer Cores,"* Page 107) is the author of several articles appearing in A.F.A. TRANSACTIONS and of two widely-used college texts, *Metal Castings* and *The Working, Heat Treating and Welding of Steel* . . . Received degree of bachelor of science in chemical engineering from the University of Michigan in 1914 . . . Master of science 1921 . . . Associate professor of metal processing at Michigan from 1921 to 1936 . . . Appointed metallurgist, American Hoist & Derrick Co., 1936 . . . At present is metallurgist, Western Foundry Co., Chicago . . . Mr. Campbell has served on several A.F.A. committees and is a member of ASM, ASTM, and ACS.

Alfred Boyles

A specialist in fundamental research in metallurgy and metallography of cast iron, Alfred Boyles (*"Gray Cast Iron—Some Principles Involved in Heat Treatment,"* Page 97) is the author of many technical papers and books on the subject . . . Born in Elkin, S.C., November 29, 1902 . . . Graduated from the University of North Carolina in 1924 . . . Joined Tennessee Coal, Iron and Railroad Co. as chemist and research metallurgist 1924-28 . . . Research metallurgist, Battelle Memorial Institute 1935 to 1941 . . .Is now with U.S. Pipe & Foundry Co., Burlington, N.J. . . . Member of A.FA, AIME, ASM and RASC.

M. E. Annich

Milton E. Annich (*"Job Evaluation System is Easily Installed,"* Page 84) is superintendent of standards for American Brake Shoe Co.'s 60 plants . . . Born August 19, 1908, in Philadelphia, he received his B.S. in Mechanical Engineering from the University of Pennsylvania in 1933 . . . Joined Brake Shoe immediately afterwards and was foreman in several of the company's foundries until 1936 . . . Has served as superintendent of Portland plant, assistant superintendent, Mahwah Plant . . . Saw two years service overseas as an officer in combat engineers and anti-aircraft units . . . Appointed superintendent of standards for Brake Shoe on his return from service . . . Would like comments from members as to whether or not they want more job evaluation information and whether the Job Evaluation and Time Study Committee might well proceed to develop a book on recommended practices.

E. C. Troy

Chairman of A.F.A.'s Philadelphia Chapter, hosts to the recent Convention, is E. C. Troy, author of *"Variable Properties Found in Western Bentonites,"* Page 111 . . . Born in Evansville, Ind., 1911 . . . Joined Detroit Steel Casting Co. in 1930 . . . Left to attend Michigan College of Mining and Metallurgy . . . Graduated, 1935, in three years . . . Joined Dodge Steel Co., Philadelphia, in 1937 as metallurgist . . . Appointed vice president in charge of research in 1947 . . . Is a research specialist in cores, sands, gating and risering . . . Mr. Troy now represents the National Engineering Co., and the Foundry Equipment Co.

F. L. Wolf

Recipient of A.F.A.'s Penton Gold Medal, Fred L. Wolf (*"Ingot Metal Vs. Virgin Metal,"* Page 94) was long a prominent member of A.F.A. and other technical associations prior to his retirement in 1945. . . . Born in Elmore, O., in 1885, Mr. Wolf graduated from the University of Michigan in 1908 with a degree in chemical engineering . . . Began with the Ohio Brass Co., Mansfield, O., in 1911 as chemist . . . Rose to the position of technical superintendent and chief engineer . . . Left in 1942 to become Chief of Graphite Section, War Production Board . . . Acted as special investigator for the Technical, Industrial Intelligence Committee in 1943 . . . In Germany and England in 1945, surveying non-ferrous foundries . . . Currently resides on a ranch near Tucson, Ariz.

W. C. Wick

William C. Wick, author of *"Oxygen-Enriched Cupola Blast,"* Page 64, is a native of Chicago . . . Served his apprenticeship with the Whiting Corp., Harvey, Ill. . . . Joined the Armour Research Foundation as a cupola operator in 1940 . . . Entered the Navy in 1943 and was associated with the Naval Research Laboratory from 1944 until his discharge in 1946 . . . Rejoined Armour Research Foundation as assistant metallurgist, his present position . . . A member of A.F.A., he was co-author of *"Insulating Pads with Riser Sleeves for Bronze Castings,"* appearing in the March, 1946, issue of AMERICAN FOUNDRYMAN.

J. E. Rehder

Canadian-born J. E. Rehder, author of *"Unusual Structures Observed in Gray Cast Irons of High Sulphur Content,"* Page 91, is a graduate of McGill University . . . Was awarded a Dawson Memorial Fellowship for his thesis . . . Joined Walker Metal Products, Windsor, Ont., as chief metallurgist in 1941 . . . Became assistant manager, Bowmanville, Ont., Foundry Co. in 1943-44 . . . Is now chief metallurgist, Grinell Company of Canada, Toronto . . . A member of A.F.A., ASTM and ASM, Mr. Rehder is the author of several articles and papers presented before technical meetings and appearing in metallurgical publications.

S. T. Jazwinski

A native of Warsaw, Poland, S. T. Jazwinski (*"Feeding Castings—A New Approach,"* Page 75) began his career as a metallurgist with the Polish Mint in Warsaw and later was a professor in the Metallurgy Department of the University of Warsaw . . . Was associated with British foundries from 1941 to 1946 as chief metallurgist and melting shop superintendent . . . While in England Mr. Jazwinski published sev-

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Secretary, V. M. Rowell, Velsicol Corp.

CINCINNATI DISTRICT CHAPTER
Secretary, E. F. Kindinger, Williams & Co., Inc.

DETROIT CHAPTER
Secretary, R. E. Cleland, Eastern Clay Products Inc.

EASTERN CANADA AND NEWFOUNDLAND CHAPTER
Secretary, J. G. Hunt, Dominion Engineering Works Ltd.

EASTERN NEW YORK CHAPTER
Secretary-Treasurer, J. A. Wettergreen, General Electric Co.

METROPOLITAN CHAPTER
Secretary, J. F. Bauer, Hickman, Williams & Co.

MEXICO CITY CHAPTER
Secretary, N. S. Covacevich, Casa Covacevich

MICHIANA CHAPTER
Secretary-Treasurer, V. S. Spears, American Wheelabrator & Equip. Co.

NORTHEASTERN OHIO CHAPTER
Secretary, R. D. Walters, Werner G. Smith Co.

NORTHERN CALIFORNIA CHAPTER
Secretary, J. F. Aicher, E. A. Wilcox Co.

NORTHERN ILLINOIS-SOUTHERN WISCONSIN
Secretary, L. C. Fill, Geo. D. Roper Corp.

NORTHWESTERN PENNSYLVANIA CHAPTER
Secretary, H. L. Gebhardt, United Oil Mfg. Co.

ONTARIO CHAPTER
Secretary-Treasurer, G. L. White, Westman Publications Ltd.

OREGON CHAPTER
Secretary-Treasurer, A. B. Holmes, Crawford & Doherty Fdry. Co.

PHILADELPHIA CHAPTER
Secretary-Treasurer, W. B. Coleman, W. B. Coleman & Co.

QUAD CITY CHAPTER
Secretary-Treasurer, C. R. Marthens, Marthens Co.

ROCHESTER CHAPTER
Secretary-Treasurer, L. C. Kimpal, Rochester Gas & Electric Corp.

SAGINAW VALLEY CHAPTER
Secretary-Treasurer, L. L. Clark, General Motors Corp.

ST. LOUIS DISTRICT CHAPTER
Secretary, P. E. Retzlaff, Bush-Sulzer Bros.-Diesel Engrg. Co.

SOUTHERN CALIFORNIA CHAPTER
Secretary, J. E. Wilson, Climax Molybdenum Co.

TENNESSEE CHAPTER
Secretary-Treasurer, A. D. Willis, U. S. Pipe & Foundry Co.

TEXAS CHAPTER
Secretary-Treasurer, H. L. Wren.

TIMBERLINE CHAPTER
Secretary, C. E. Stull, Manufacturers Foundry Corp.

TOLEDO CHAPTER
Secretary-Treasurer, R. H. Van Hellen, Unitcast Corp.

TRI-STATE CHAPTER
Secretary, C. B. Fisher, Enardo Foundry & Mfg. Co.

TWIN CITY CHAPTER
Secretary-Treasurer, L. K. Polzin, Minneapolis Chamber of Commerce.

WASHINGTON CHAPTER
Secretary-Treasurer, A. D. Cummings, Western Foundry Sand Co.

WESTERN MICHIGAN CHAPTER
Secretary, D. A. Paull, Sealed Power Corp.

WESTERN NEW YORK CHAPTER
Secretary, F. L. Weaver, Weaver Materiel Service.

WISCONSIN CHAPTER
Secretary, A. C. Haack, Wisconsin Grey Iron Foundry Co.

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STUDENT CHAPTERS

UNIVERSITY OF MINNESOTA *Secretary,* Harvey Sauby

MISSOURI SCHOOL OF MINES *Secretary,* Stanley Zirinsky

OHIO STATE UNIVERSITY *Secretary-Treasurer,* Eldon Boner

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Secretary-Treasurer, Martin J. O'Brien

OREGON STATE COLLEGE
Secretary, John P. Meece

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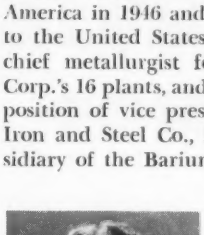
eral technical papers and a book, *"Iron Alloys Technology"* . . . His method of feeding castings, developed in England, was patented in practically every country in the world . . . Left England for South America in 1946 and soon afterward came to the United States . . . Was appointed chief metallurgist for the Barium Steel Corp.'s 16 plants, and in addition holds the position of vice president of the Sheffield Iron and Steel Co., Sheffield, Ala., a subsidiary of the Barium Steel Corp.



Dr. H. A. Vonachen

Founder of the nationally-known "Peoria Plan" for rehabilitating veterans, and recipient of the 1943-44 Knudsen Award for the year's most outstanding contribution to industrial medicine is Dr. H. A. Vonachen (*"Industrial Health Programs in Action,"* Page 88) . . . Born in Peoria, Ill., Dr. Vonachen attended Spalding Institute, St. Viator College, Bradley University and St. Louis University. . . Served in World War I as Medical Corps private . . . In World War II as vice commander, Coast Guard Auxiliary . . . Appointed medical director, Caterpillar Tractor Co. in 1927 . . . Cited by D.A.V. for employing 800 disabled persons at Caterpillar . . . A member of several medical societies, Dr Vonachen is president of the American Association of Industrial Physicians and Surgeons, ex-president and staff member of St. Francis hospital, Peoria, and a director of the Central States Industrial Physicians and Surgeons.

J. A. McIntosh

James A. McIntosh, author of *"Pattern Equipment—Mechanized Production of Light Castings,"* page 81, is assistant works manager of Smith & Wellstood, Ltd., Bonnybridge, Scotland, where he has worked since 1937. Starting as a patternmaker with his present company, he was assistant superintendent of the castings control department, 1939-1940 . . . The following eight years he was assistant superintendent of the molding department . . . Prior to going to work with Smith & Wellstood, Mr. McIntosh worked as a patternmaker for plants in Falkirk, where he was born, September 5, 1914 . . . An associate member of the Institute of British Foundrymen, he has written technical papers for that organization and for *Foundry Trade Journal* . . . He holds diplomas in patternmaking and in iron founding from the Falkirk Technical School . . . Also holds a certificate for foundry science and technology from the City & Guilds of London Institute . . . From Glasgow Technical College Mr. McIntosh has a certificate of merit for foundry work.

CHAPTER ELECTIONS

Twin City Chapter

(Election Held April 1)

Chairman—Carleton C. Hitchcock, Partner, R. C. Hitchcock & Sons, 3023 Snelling Ave., Minneapolis 6, Minn.

Vice-Chairman—Franklin A .Austin, Vice-Pres., Crown Iron Works Co., 1950 Ulysses St., N.E., Minneapolis, Minn.

Secretary-Treasurer—Lillian K. Polzin, Director, Manufacturers' Secretariat, Minneapolis Chamber of Commerce, 100 Pillsbury Building, Minneapolis 2, Minn.

Directors—Terms Expire 1949

S. L. Cameron, Jr., Vice-Pres., Valley Iron Works. Inc., 81 E. Water, St. Paul, Minn.

E. R. Frost, Pres., The E. R. Frost Co., 1179 15th Ave., S.E. Minneapolis 14, Minn.

Sheldon J. Pufahl, Pres., Pufahl Fdry., Inc., Como Ave. S.E. & City Limits, Minneapolis 14, Minn.

Robert C. Wood, Vice-Pres., Minneapolis Electric Steel Cstgs. Co., 3800 5th St. N.E., Minneapolis 18, Minn.

Terms Expire 1950

Clarence J. Becker, V.P. & Treas., Union Brass & Metal Mfg. Co., 501 W. Lawson Ave., St. Paul, Minn.

Charles Kausel, Secy.-Treas., Kausal Foundry Co., 2555 Ulysses St. N.E., Minneapolis 13, Minn.

Francis J. Marrin, Pres., Marrin Foundry, Inc., 416 Lincoln St. N.E., Minneapolis, Minn.

Terms Expire 1951

Joseph W. Costello, Patt. Shop Frm., American Hoist & Derrick Co., 1319 W. Idaho Ave., St. Paul, Minn.

Carl W. Olson, Jr., Fdry. Mgr., C. W. Olson Manufacturing Co., 1300 Quincy St. N.E., Minneapolis 13, Minn.

C. Fred Quest, Asst. Mgr., J. F. Quest Foundry Co., 900 S. 4th St., Minneapolis 15, Minn.

Metropolitan Chapter

(Election Held April 15)

Chairman—John A. Bukowski, Works Met., Worthington Pump & Mach. Corp., Harrison, N.J.

Vice-Chairman—Thomas J. Wood, Fdry. Supt., American Brake Shoe Company, Mahwah, N.J.

Secretary—J. Fred Bauer, Salesman, Hickman, Williams & Co., 70 Pine St., New York 5, N.Y.

Treasurer—D. Polderman, Jr., V.P. & Export Mgr., Whiting Corp., 30 Church St., New York, N.Y.

Directors—Terms Expire 1949

D. W. Talbot, General Manager, Cooper Alloy Foundry Co., Hillside, N.J.

Williams F. Rose, Representative, Smith Oil and Refining Co., Ramsey, N.J.

R. D. Speirs, Pattern Superintendent, Wright Aeronautical Corp., Woodridge, N.J.

R. A. Flinn, Jr., Metallurgist, American Brake Shoe Co., Mahwah, N.J.

J. S. Vanick, Metallurgist, International Nickel Co., New York, N.Y.

Terms Expire 1950

Frank B. Eliason, Pennsylvania Foundry Supply & Sand Co., Philadelphia, Pa.

Ernest R. Miller, Fdry. Supt., Bethlehem Steel Co., Staten Island 3, N.Y.

John Van Haver, Worthington Pump & Machinery Corp., Harrison, N.J.

Robert G. Pitz, Pitz Foundry, Inc., Brooklyn, N.Y.

Aubrey E. Winsted, Moore Brothers Co., Elizabeth, N.J.

Philadelphia Chapter

(Election held April 21)

Chairman—C. L. Lane, Met., Florence Pipe Foundry & Machine Co., 4 Church St., Florence, N.J.

Vice-Chairman—W. A. Morley, Fdry. Mgr., Olney Foundry Div., Link-Belt Co., 180 W. Duncannon Ave., Philadelphia 20, Pa.

Secretary Treasurer—W. B. Coleman, Pres., W. B. Coleman & Co., 9th & Rising Sun Ave., Philadelphia 40, Pa.

Directors—Terms Expire 1949

William Morley, Foundry Manager, Olney Foundry Division, Link-Belt Co., Philadelphia.

A. C. Gocher, Foundry Superintendent, Fletcher Works, Inc., Philadelphia.

Terms Expire 1950

C. B. Jenni, Metallurgist, General Steel Castings Corp., Philadelphia.

W. B. Wilkins, President and General Manager, American Manganese Bronze Co., Philadelphia.

Terms Expire 1951

J. L. Furey, Sales Engr., Swan-Finch Oil Corp., Cheltanham, Pa.

George Bradshaw, Master Molder, Philadelphia Navy Yard, Philadelphia, Pa.

Chicago's Largest Aluminum Casting Poured for Veneer Slicing Machine

A MASSIVE ALUMINUM CASTING, believed the largest ever poured in the Chicago area, was recently produced by Hodgson Foundry Co. of that city for Clearing (Ill.) Machine Corp., for use in a veneer slicing machine.

Six tilting furnaces were required to produce molten metal (No. 12 Aluminum), which was fed to two holding ladles until enough was available to fill the mold. The mold was of regular No. 1 Albany sand. Holes and the inside of the casting were cored.

Metal was poured at three gates, and six risers, each of 4-in. diameter and 1-ft height, were used. To promote feeding, a new exothermic material developed for aluminum alloys was placed in the risers. The company reports that the metal in the risers remained liquid while four additions were made; that the casting was fed perfectly, and that no shrinkage cracks were encountered in the casting.

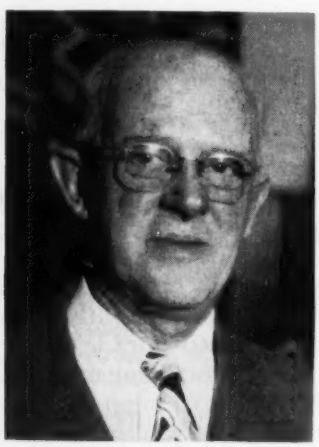
Overall dimensions of the castings are: length, 15 ft, 9 in.; width, 4 ft, 8 in.; height, 6 in, Metal thickness is 1¼ in.; weight after cleaning 2350 lb.

FOUNDRY Personalities

Ray Frings, chief metallurgist, Central Foundry Co., Holt, Ala., recently resigned to accept a position as sales representative for Harry G. Mouat, foundry manufacturer's representative, Birmingham, Alabama. Mr. Frings joined Central in 1944 as supervisor of the company's newly-created Industrial Engineering department. He maintained supervision of this department, along with that of the Metallurgical department, until his resignation. Mr. Frings will be succeeded in the Industrial Engineering department by **Perry Standridge** and in the metallurgical department by **K. P. Efird.**

William S. Lambie, senior vice president of the National City Bank of New York, and **George D. Branston,** industrial consultant, have been elected to the board of directors of the Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.

William G. Mixer, general superintendent of the Buick Motor Co. Foundry, Flint, Mich., was recently the speaker at seven colleges in the East and Midwest under the sponsorship of the Foundry Educational Foundation. Mr. Mixer spoke at Northwestern University, the University of Wisconsin, Case Institute of Technology, Ohio

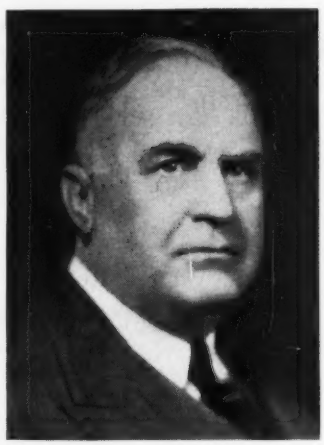


W. G. Mixer

State University, the University of Cincinnati, Cornell University and the Massachusetts Institute of Technology between April 8 and May 13.

Webster B. Todd, formerly chairman of the board of Todd & Brown, Inc., was recently appointed to the executive committee of the American Wheelabrator & Equipment Corp., Mishawaka, Ind. Mr. Todd is also a member of the board of directors. The firm of Todd & Brown was instrumental in planning and supervising the construction of Rockefeller Center and the Williamsburg, Va., colonial restoration. During the war, under Mr. Todd's direction, the firm operated the Kingsbury Ordnance Plant at Laporte, Ind.

William C. Appleby, assistant to the president, Southern Wheel division, American Brake Shoe Co., has retired after 42



W. C. Appleby

years of service with the company. Mr. Appleby served for nearly 23 years in various supervisory capacities in company plants in the South. He was transferred to New York in 1929 and became assistant to the president of Southern Wheel division in 1944. A native of Georgia, he is a graduate of Georgia School of Technology.

Arthur C. Croft, president of the National Foremen's Institute, has been elected a director of the Western Foundry Co., Chicago, it is announced by D. A. Cullinan, president. Mr. Croft was formerly in an executive capacity with McGraw-Hill Publishing Co. and the A. W. Shaw Co.

Irwin F. Holland, general superintendent of the Small Tool and Gage division, Pratt & Whitney, was recently named president of the American Society of Tool Engineers. Other officers elected were: **R. B. Douglas,** Godscroft Industries, Ltd., Montreal, first vice-president; **H. L. Tigges,** Baker Bros., Inc., Toledo, O., second vice president; **V. H. Ericson,** Johnson de Vou, Inc., Worcester, Mass., third vice president; **George A. Goodwin,** Master Electric Co., Dayton, O., treasurer; and **W. B. McClellan,** Gairing Tool Co., Detroit, secretary.

J. J. Grady was recently elected president and a director of Exothermic Alloys Sales and Service, Inc., Chicago, to fill a vacancy caused by the resignation of **F. J. Griffiths. D. V. Hamilton,** sales manager, was also elected a director of the company, and **D. D. Tipton** was appointed treasurer.

Dr. Robert F. Mehl, head of the Department of Engineering at the Carnegie Institute of Technology, will deliver the Hatfield Memorial Lecture at the annual meeting of the Iron and Steel Institute of England this month. Dr. Mehl will speak on the fundamentals of heat treatment of steel. The lecture is sponsored by Sheffield University, the Iron and Steel Institute and the Royal Society. Established in 1944, the Hatfield Memorial Lecture is presented annually by an invited speaker selected by the sponsors.

Dr. Mehl, a former National Research Fellow at Harvard university, from 1925 to 1927, served as superintendent of the Division of Physical Metallurgy of the Naval Research Laboratory, Washington. During the war he held the rank of brigadier general and was an attache at the U. S. Embassy in London.

The Mathieson Chemical Corporation announces the election of **Thomas S. Nichols** as president and chief executive officer. **George W. Dolan,** formerly president, was elected chairman of the board. **A. U. Fox,** former chairman, resigned. **John C. Leppert** was elected vice president. Officers re-elected are **A. T. Bennett,** vice

T. S. Nichols

president-general manager of operations; **Howard Berry,** vice president and treasurer; **D. W. Drummond,** vice president-general manager of sales; **J. V. Joyce,** vice president and comptroller; **E. E. Routh,** vice president-director of sales; and **A. P. Winsor,** secretary.

Frank B. Newbert has been appointed assistant general purchasing agent for the American Brake Shoe Co. Mr. Newbert has been with Brake Shoe since 1934 in various purchasing capacities. He is a graduate of Rider College, Trenton, N.J.

Richard **H. Nathan** has been appointed vice president of the Pulaski Iron and Metal Co., Houston, Tex. Mr. Nathan was formerly with the Federated Metals Division of the American Smelting & Refining Co. for more than 22 years.

Two appointments are announced by the Swan Finch Oil Co.: **Nelson V. Joyce,** to be vice president in charge of purchasing; and **John M. Parker, Jr.,** to be sales manager of the tractor division. Mr. Joyce, formerly vice president in charge of the company's Western department, joined Swan-Finch as a salesman in 1910. Mr. Parker, formerly sales manager of the Pacific tractor division, came to Swan-Finch as a salesman in 1936.

Frank E. Wartgow has been elected vice president of Castle & Associates, Inc., Chicago personnel counselors, and will be in charge of that organization's newly-formed foundry division, which offers a specialized personnel service to the foundry industry. Mr. Wartgow was formerly exhibit

F. E. Wartgow

manager on A.F.A.'s National Staff, and prior to that served as secretary-treasurer and later vice-president of the Chicago chapter. Mr. Wartgow has been associated with Inland Steel Co., Liquid Carbonic Corp. and American Steel Foundries, all of Chicago, in supervisory engineering capacities. Prior to accepting his present position with Castle & Associates, Mr. Wartgow was with the sales department of the Whiting Corp., Harvey, Ill.

Edward J. Duffy, formerly superintendent of the Iron Production division at Kaiser-Frazer Corp.'s Fontana, Calif., plant has been appointed manager of the company's new Ironton blast furnace division at Provo, Utah. A veteran of nearly 30 years in the iron and steel industry, Mr. Duffy has been with Kaiser-Frazer since its entry into the steel business in 1942.

The Waterbury Farrell Foundry & Machine Co., Waterbury, Conn., announces the reelection of its chief executive officers and four new executive promotions. Reelected are **D. C. Griggs,** chairman of the board; **R. L. Wilcox,** president; **Z. P. Candee,** vice president; **L. S. Reed,** treasurer; **E. A. Anderson,** secretary; and **A. D. Mitchell,** assistant secretary and controller. Newly-promoted are **I. H. Tolles,** assistant secretary, to be vice president and director; **J. H. Schaeffer,** engineer, to vice president; **S. Van Valkenburg,** engineer, to vice president; and **W. T. Bannon,** personnel director, to assistant secretary.

D. A. Paull, on special assignment with the works manager's staff of the Sealed Power Corp., Muskegon, Mich., will manage the corporation's new Ionia, Mich., plant. The plant, started this spring, will manufacture castings for piston rings. Mr. Paull, who has been with Sealed Power since 1942, has long been active in A.F.A.'s Western Michigan Chapter.

J. A. Butler has been named treasurer of the Falk Corp., Milwaukee. Formerly assistant treasurer and comptroller, Mr. Butler has been with Falk since 1937. Mr. Butler is succeeded by **Joseph B. Cibulka,** formerly assistant comptroller.

Dr. Haldon A. Leedy, chairman of physics research at Armour Research Foundation, Chicago, has been named acting director of the Foundation, succeeding Dr. Jesse E. Hobson, who resigned recently to accept directorship of the Stanford Research Institute.

John B. Morrow, Jr., superintendent of the Portsmouth, Va., plant of the American Brake Shoe Co., has been appointed personnel manager for the company's Southern Wheel Division. Mr. Morrow will be in charge of labor relations and safety activities in his new position. He has been with Brake Shoe for 28 years.

The appointment of **Robert P. Schauss** as foundry engineer, Western area, is announced by Arthur S. Nichols, vice president, Illinois Clay Products Co., Chicago. Mr. Schauss, a graduate of Case Institute of Technology, was formerly malleable foundry superintendent, National Malleable & Castings Co., Cicero, Ill. He is a member of A.F.A.'s College Research Projects committee, the Malleable Executive committee, secretary of the Malleable Program and Papers committee, and chairman of the Malleable Controlled Annealing committee. **Richard D. Bailey,** formerly of Ferro Machine & Foundry Co., Cleveland, has been appointed foundry engineer of Illinois Clay Products Co. Eastern area, served by the new Pedro plant in southeastern Ohio.

Joseph P. Kleimkort, Eastern District sales manager of the American Brake Shoe Co., has been appointed general sales manager of the company's Ramapo Ajax division, and will be located at Brake Shoe's general offices, Chicago.

W. E. Quillian has been appointed chief estimator and purchasing agent of the Salem Engineering Co.'s South West branch, Fort Worth, Tex. Mr. Quillian was formerly chief estimator at the company's main office at Salem, O.

Julius W. Marx has been appointed chief engineer of the Newcomb-Detroit Co., Detroit. Mr. Marx was formerly plant engineer at General Motors Truck and Coach division.

John H. Smith, formerly vice president in charge of the marketing division of the General Electric X-Ray Corp., has been appointed executive vice president and a member of the company's board of directors. He was formerly general sales manager of the General Cable Corp., New York.

Harry J. Sprecken, Jr., supervisor of Automotive Foundries, International Harvester Co., Chicago, has announced his retirement effective April 1. Mr. Sprecken first joined International Harvester in 1922 as superintendent of the gray iron foundry at the company's Tractor Works. In 1930 he was made supervisor of all automotive foundries. Mr. Sprecken's home address is Box 156, Baldwin, Mich.

G. R. Buhler, assistant editor of AMERICAN FOUNDRYMAN, resigned March 15 and is now associated with his father in the latter's printing business, the Home Pub-

G. R. Buhler

lishing Co., Hammond, Ind. Coming to A.F.A. headquarters direct from the University of Illinois, he worked in various departments and on a number of A.F.A. publications. A lieutenant (j.g.) in the Navy, he was discharged in 1944 after two years service and rejoined the A.F.A. staff in April 1945.

Recent additions and changes in the sales staff of the Foundry Equipment Co., Cleveland are: **E. C. Troy,** to serve as sales engineer in eastern Pennsylvania, New Jersey, Maryland and Delaware; and **Fred W. Fuller,** to be sales engineer for northern Ohio, excepting Williams, Fulton and Lucas counties. Both Mr. Fuller and Mr. Troy, who recently resigned as vice president of Dodge Steel Co., Philadelphia, will also represent the National Engineering Co. in their respective territories.

E. A. Pratt, New York consulting engineer, has been appointed to represent the International Organization for Standardization in its relations with the Economic and Social Council of the United Nations. Mr. Pratt was a member of the staff of the American Standards association and has represented American companies in Europe, Asia, Africa and South America.

New AFA MEMBERS

Period March 15 - April 15: 199 new members were added to the American Foundrymen's Association during this period. Chapters leading the membership increase are: Oregon State College (chapter recently approved), 27; Birmingham District, 23; Tennessee, 16; Saginaw Valley, 10.

NEW COMPANY MEMBERS

Combustion Engineering Co. Inc., Chattanooga, Tenn.—Sam C. Northington, Fdry. Supt. (Tennessee Chapter).

International Harvester Co., Memphis Works, Memphis, Tenn.—Ed. Boywid, Fdry. Supt. (Non-Chapter).

National Bronze & Aluminum Foundry, Cleveland—Wm. K. Southgate, Asst. to Pres. (Northeastern Ohio Chapter).

New York Sand & Facing Co., Brooklyn, N.Y.—Robert B. Munn, Asst. Sls. Mgr. (Metropolitan Chapter).

Noblesville Casting Co., Noblesville, Ind.—Gordon A. Baugh, Partner, (Central Indiana Chapter).

Precision Patterns Inc., Buffalo, N.Y.—Norbert W. Pohlman, Secretary, (Western New York Chapter).

Pullman-Standard Car Mfg. Co., Chicago—Howard A. Lang, Gen. Fore., (Chicago Chapter).

Superheater Co. Ltd., Sherbrooke, Que., Canada—J. Lefebvre, Fdry. Fore., Eastern Canada & Newfoundland Chapter).

Tennessee Products & Chemicals Corp., Nashville, Tenn.—M. H. Nabors, Sls. Mgr. (Tennessee Chapter).

Valley Steel Casting Co., Bay City, Mich.—Mendel A. Fair, Owner & Gen. Mgr. (Saginaw Valley Chapter).

BIRMINGHAM DISTRICT CHAPTER

E. M. Battle, Conv. Frm., Jackson Industries, Inc., Production Foundries Div., Birmingham.
John Bright, Core Rm. Frm., Jackson Industries, Inc., Production Foundries Div., Birmingham.
V. I. Byford, Gen. Fdry. Frm., Jackson Industries, Inc., Production Foundries Div., Birmingham.
E. M. Foster, Frm., Jackson Industries, Inc., Production Foundries Div., Birmingham.
Y. Z. Garner, Frm., Jackson Industries, Inc., Production Foundries Div., Birmingham.
W. C. Jeffery, Jackson Industries, Inc., Production Foundries Div., Birmingham.
J. R. Keller, Asst. Mgr., Keller Foundry Co., Knoxville, Tenn.
J. R. Long, Pchs. Agt., Jackson Industries, Inc., Production Foundries Div., Birmingham.
J. H. Marsh, Mold. Frm., Stockham Pipe Fittings Co., Birmingham.
J. T. Mayes, Cln. Rm. Frm., Jackson Industries, Inc., Production Foundries Div., Birmingham.
A. R. Miles, Owner, Sedgefield Foundry Co., Greensboro, N.C.
H. J. O'Neal, Jackson Industries, Inc., Production Foundries Div., Birmingham.
Howard Prather, Frm., Jackson Industries, Inc., Production Foundries Div., Birmingham.
Pete Ranoont, Jr., Mold. Frm., Stockham Pipe Fittings Co., Birmingham.
D. W. Reeves, Tapping Supt., Stockham Pipe Fittings Co., Birmingham.
J. H. Reeves, Fdry. Supt., Stockham Pipe Fittings Co., Birmingham.
J. Paul Singleton, Wks. Mgr., Central Foundry Co., Holt, Ala.
E. L. Smith, Chief Insp., Jackson Industries, Inc., Production Foundries Div., Birmingham.
W. H. Spencer, Coke Engr., DeBardeleben Coal Corp., Birmingham.
H. A. Swanzey, Dir. Indl. Relations, Jackson Industries, Inc., Production Foundries Div., Birmingham.
W. C. Thompson, V.P., Chg. of Prod., Charlotte Pipe & Foundry Co., Charlotte, N.C.
Loyd Tice, Frm., Jackson Industries, Inc., Production Foundries Div., Birmingham.
K. P. Young, Mold. Frm., Stockham Pipe Fittings Co., Birmingham.

BRITISH COLUMBIA CHAPTER

G. R. Heffernan, Met., Westland Iron & Steel Foundries Ltd., Vancouver.
T. H. Sneddon, Gen. Supt., Westland Iron & Steel Foundries Ltd., Vancouver.
David Wiseman, Lab. Asst., Westland Iron & Steel Foundries Ltd., Vancouver.

CANTON DISTRICT CHAPTER

C. G. Basler, Sls., A. P. Green Firebrick Co., Mexico, Mo.
R. G. Griffin, Wks. Acct., Stark Foundry Co., Canton, Ohio.
F. J. Hushea, Pres., Ohio Optical Co., Canton, Ohio.
Alexander Prentice, Mgr., Stark Foundry Co., Canton, Ohio.

CENTRAL ILLINOIS CHAPTER

F. W. Cash, Bookkeeper, Pekin Foundry & Mfg. Co., Pekin, Ill.
A. J. Paul, Malleable Cstgs. Buyer, Caterpillar Tractor Co., Peoria, Ill.
Frank Wolgamott, Electrical Contractor, (Self) Pekin, Ill.

CENTRAL INDIANA CHAPTER

***Noblesville Casting Co., Noblesville, Ind. (Gordon A. Baugh, Partner).**
John S. Hopkins, Engr., Advance Stove Works, Evansville, Ind.

CENTRAL MICHIGAN CHAPTER

A. H. Bouldin, Dir. of Per. Rel., Albion Malleable Iron Co., Albion, Mich.
E. F. Kotz, Frm. Patt. Maint., Albion Malleable Iron Co., Albion, Mich.
K. L. Sanders, Tool & Die Engr., Albion Malleable Iron Co., Albion, Mich.

CENTRAL NEW YORK CHAPTER

W. F. Grandy, Refractories Sls., Robinson Clay Product Co., Syracuse, N.Y.
A. H. Moon, Met. Engr., Cornell University, Ithaca, N.Y.
Nicholas Sheptak, Met. Engr., Cornell University, Ithaca, N.Y.
Hal Woodul, Sls. Engr., Ingersoll-Rand Co., New York, N.Y.

CHESAPEAKE CHAPTER

C. W. Cooper, Supv., Naval Research Laboratory, Bellevue, Washington 20, D.C.

CHICAGO CHAPTER

***Pullman-Standard Car Mfg. Co., Chicago. (Howard A. Lang, Gen. Frm.).**
Elmer Ahlberg, Pattmkr., Urschel Laboratory, Inc., Valparaiso, Ind.
Kenneth Cooper, Asst. Patt. Frm., Pullman-Standard Car Mfg. Co., Chicago.
Lee Cress, (Partner) Owner, James Haxton & Sons Co., Chicago.
R. A. Heehs, Field Engr., Roots-Connersville Blower Corp., Chicago.
C. F. Nelson, Patt. & Fdry. Frm., Pullman-Standard Car Mfg. Co., Chicago.
H. S. Schlettert, Supt. Wheel Fdries., Pullman-Standard Car Mfg. Co., Chicago.
James Sciacero, Asst. Fdry. Frm., Pullman-Standard Car Mfg. Co., Chicago.
A. B. Scott, Jr., American Steel Foundries, Indiana Harbor Works, E. Chicago, Ind.

CINCINNATI DISTRICT CHAPTER

C. E. Cofield, Supv., The Williamson Heater Co., Cincinnati.
J. H. Pearson, Chief Indl. Engr., The Williamson Heater Co., Concinnati.
Jacob Roden, Jr., Patt. Supv., The Williamson Heater Co., Cincinnati.
A. F. Schmidt, Asst. Pur. Agt., The Lunkenheimer Co., Cincinnati.

DETROIT CHAPTER

R. A. Irvin, Mgr., Bullard Gage Co., Detroit.
E. C. Slayman, Sls. Mgr., Bullard Gage Co., Detroit.
Ernie Vick, Sls. Rep., Duquesne Smelting Corp., Detroit.

E. CANADA & NEWFOUNDLAND CHAPTER

***The Superheater Co. Ltd., Sherbrooke, Que. (J. Lefebvre, Fdry. Frm.).**
W. R. Hall, Pattmkr. Frm., Aluminum Co. of America, Massena, N.Y.
E. Murphy, Frm., Canadian Car & Foundry Co. Ltd., Montreal, Que.
Robert Woods, Asst. Supt., Montreal Bronze, Ltd., Montreal, Que.

EASTERN NEW YORK CHAPTER

F. A. Rothery, Sls., Bay State Refining Co. Inc., Chicopee Falls, Mass.
H. S. Thompson, Indl. Engr., George H. Elliott & Co., New York, N.Y.

METROPOLITAN CHAPTER

***New York Sand & Facing Co., Brooklyn, N.Y. (R .B. Munn, Asst. Sls. Mgr.).**
R. J. Hashagen, 690 Garfield Ave., Jersey City, N.J.
N. C. Martin, Sls. Engr., American Cyanamid Co., New York, N.Y.
Martin Qualantone, Fdry. Tech., 12-33 Lexington St., Fairlawn, N.J.

MEXICO CITY CHAPTER

Francisco Rojo, Funiciones De Hierro Y Acero, S.A., San Pedro de los Pinos.

MICHIANA CHAPTER

K. E. Blessing, Sls. Engr., American Wheelabrator & Equipment Corp., Mishawaka, Ind.
J. MacDonald, Nylen Products, St. Joseph, Mich.

* Company Members

NORTHEASTERN OHIO CHAPTER

*National Bronze & Aluminum Foundry, Cleveland. (W. K. Southgate, Asst. to Pres.).
Henry Apthorp, Indl. Sls. Engr., East Ohio Gas Co., Cleveland.
Fred Cibula, Owner, Western Aluminum Match Plate Co., Cleveland.
F. A. Henz, Gen. Mgr., Western Aluminum Match Plate Co., Cleveland.
A. J. Kingseed, Asst. Wks. Mgr., Farrell-Cheek Steel Co., Sandusky, Ohio.
R. G. Seidel, Mech. Engr., National Malleable & Steel Castings Co., Cleveland.

NO. ILLINOIS & SO. WISCONSIN CHAPTER

Martin Putz, Fdry. Supt., Fairbanks, Morse & Co., Freeport, Ill.

NORTHWESTERN PENNSYLVANIA CHAPTER

C. E. Anderson, Met., Erie Malleable Iron Co., Erie, Pa.
E. A. Ferbert, Sls., Pickands-Mather Co., Erie, Pa.
H. W. Martin, Fdry. Supt., Erie City Iron Works, Erie, Pa.
R. C. Owens, Frm., Erie Malleable Iron Co., Erie, Pa.

OREGON CHAPTER

Larry Brumage, Frm. Warehouse & Shipping, Electric Steel Foundry Co., Portland.
J. T. Dorigan, Timekeeper, Electric Steel Foundry, Portland.
D. T. Fredericks, Owner, Quality Pattern Works, Portland.

PHILADELPHIA CHAPTER

J. N. Cronin, Fdry. Frm., Fletcher Works, Inc., Philadelphia.
S. A. Gilbert, Engr., American Briquet Co., Philadelphia.
William Grimm, Owner, William Grimm Brass Foundry, Philadelphia.
William E. Hoffman, Cons. & Sls., Wm. E. Hoffman & Son, Reiffton, Pa.
W. J. Griffith, Pres., Griffith-Raguse & Co. Inc., Philadelphia.
R. L. Peck, Refr. Engr., Norton Co., Worcester, Mass.
J. S. Sabol, Mold. Supv., Link-Belt Co., Olney Foundry, Philadelphia.
R. S. Trimble, Sales Engr., Simonds Abrasive Co., Philadelphia.
G. W. Wileman, Owner, Philadelphia.

QUAD CITY CHAPTER

F. L. Bredt, Supv., Rate & Method Dept., J. I. Case Co., Rock Island, Ill.
M. B. Fierke, Plant Engr., J. I. Case Co., Rock Island, Ill.
V. W. Kohrs, Fdry. Engr., J. I. Case Co., Rock Island, Ill.

ROCHESTER CHAPTER

R. J. Barr, Prop., Rochester Steel Treating Works, Rochester.

SAGINAW VALLEY CHAPTER

*Valley Steel Casting Co., Bay City, Mich. (M. A. Fair, Owner & Gen. Mgr.).
G. A. Barker, Cln. Rm. Frm., Valley Steel Casting Co., Bay City, Mich.
F. W. Evans, Frm., Core Dept., Chevrolet Gray Iron Foundry, GMC., Saginaw, Mich.
C. H. Hammer, Student, General Motors Institute, Saginaw Malleable Iron Plant, Saginaw.
D. J. Hickey, Student, General Motors Institute, Saginaw Malleable Iron Plant, Saginaw.
A. J. Lent, Supt., United States Graphite Co., Saginaw, Mich.
D. H. Murray, Standards Dept., Chevrolet Gray Iron Foundry, GMC., Saginaw.
M. F. North, Per. Investigator, Chevrolet Gray Iron Foundry, GMC., Saginaw.
Leo Piesik, Mold. Frm., Valley Steel Casting Co., Bay City, Mich.
E. C. Roth, Frm., Fdry. Div., Chevrolet Gray Iron Foundry, GMC., Saginaw.

ST. LOUIS DISTRICT CHAPTER

R. M. Conklin, Frm., City Plating & Mfg. Co., St. Louis.
William Guiot, Fdry. Frm., General Steel Castings Corp., Granite City, Ill.
Ralph Guntly, Fdry. Frm., General Steel Castings Corp., Granite City, Ill.
James Maddern, Chemalloy Foundry, Louisiana, Mo.
J. R. Patton, Chief Chem., General Steel Castings Corp., Granite City, Ill.
Frank Poettgen, Killark Electric Mfg. Co., St. Louis.
G. A. Watkins, Spec. Appr., National Bearing Division, American Brake Shoe Co., St. Louis.

SOUTHERN CALIFORNIA CHAPTER

F. W. Wells, Construction Products Corp., Lynwood, Calif.

TENNESSEE CHAPTER

*Combustion Engineering Co., Inc., Chattanooga. (S. C. Northington, Fdry. Supt.).
*Tennessee Products & Chemical Corp., Nashville. (M. H. Nabors, Sls. Mgr.).
W. C. Cate, Chief Chemist, Crane Co., Chattanooga Div., Chattanooga.
Lynn Deakins, Partner, Peirson-Deakins, Chattanooga.
H. W. Dent, Partner, Manufacturers Equipment & Supply Co., Chattanooga.
W. K. Hailey, Sec., Moccasin Bushing Co., Chattanooga.
W. G. Hampton, Partner, Manufacturers Equipment & Supply Co., Chattanooga.
R. A. Jacobs, Supt., Jacobs Mfg. Co., Bridgeport, Ala.
J. F. Johnson, Chemist, U. S. Pipe & Foundry Co., Chattanooga.
John Lumpkin, Master Mech., U. S. Pipe Co., Chattanooga.
E. W. Peirson, Partner, Peirson-Deakins, Chattanooga.
C. P. Powell, Supt. Boiler & Radiator, Crane Co., Chattanooga Div., Chattanooga.
P. A. Rucker, Fdry. Supt., Sanford Day Iron Work, Knoxville.
H. L. Suplee, V.P., Charge of Operations, Ross Meehan Foundries, Chattanooga.
J. A. Wagner, Met., Harrison-Corry Co., Knoxville.
W. W. Westler, Acting Supt. Meehanite Foundry, Ross-Meehan Foundries,

TIMBERLINE CHAPTER

R. C. Baker, Molder Frm., Western Foundry, Denver, Colo.
Dewey Stevens, Molder, McPherson Corp., Denver, Colo.

TOLEDO CHAPTER

W. T. Ford, Dist. Rep., Mexico Refractories Co., Toledo, Ohio.
L. P. Henry, Sls., Monroe Steel Castings Co., Monroe, Mich.

WASHINGTON CHAPTER

R. G. Hoag, Sls. Mgr., General Metals Corp., Seattle.
F. H. Wetmore, Pattmkr. Appr., Stetson-Ross Machine Co., Seattle.

WESTERN MICHIGAN CHAPTER

John Borgman, Fdry. Supt., Sealed Power Co., Muskegon, Mich.
J. R. Goudzwaard, Mgmt. Appr., Campbell, Wyant, & Cannon Foundry Co., Muskegon Hgts.
W. E. Malpass, Partner, East Jordan Iron Works, East Jordon, Mich.
Richard Schwass, Supt. Metal Patt. Dept., Lakey Foundry & Machine Co., Muskegon.

WESTERN NEW YORK CHAPTER

*Precision Patterns, Inc., Buffalo. (N. A. Pohlman, Sec.).
Douglas Hollister, Sls. Rep., United States Graphite Co., Saginaw, Mich.
Ralph J. O'Brian, Sls. Engr., Robinson Clay Products Co., Buffalo.
A. W. Spencer, Buyer, American Machine & Foundry Co., Buffalo.

WISCONSIN CHAPTER

R. A. Berthold, Coremaker, Allis-Chalmers Mfg. Co., West Allis, Wis.
Donald Dingwall, Plastic Corp. of Milwaukee, Sussex, Wis.
E. A. Erdman, Met., Cutler-Hammer, Inc., Milwaukee.
Frank Kuras, Owner, State Pattern Works, Milwaukee.
John Rittenhouse, Instr., Met., Marquette University, Milwaukee.
C. A. Shem, Jr., Sales, Werner G. Smith Co., Milwaukee.

STUDENT CHAPTERS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY STUDENT CHAPTER

Charles A. Licht
Charles M. Nohavec

OHIO STATE UNIVERSITY STUDENT CHAPTER

Harold J. Gonya
H. A. Holland
D. M. Marsh
Earl Smith, Jr.
Reginald Smith
A. E. Stoner
R. A. Yeager, Jr.

OREGON STATE COLLEGE STUDENT CHAPTER

Dwight W. Averill
Douglas Blair
David E. Crabtree
Earl E. Hawks
H. J. Head
Fred B. Gotter
Gilbert V. Kamara
Charles E. Lauderdale
John Meece
Wyman F. Mills
John F. Oettinger
Edwin F. Otey
Robert R. Peel
Roby Earl Poffenberger
Leonard M. Preston
William Lloyd Regele
Robert J. Reid
Glen S. Shepard
James H. Skeel
Keith N. Soderlund
Ted Sullivan, Jr.
D. H. Swartz
Everett M. Uebel
Bill Waite
Russell A. Ward
Walter A. Wilson
D. H. Wissenback

OUTSIDE OF CHAPTER

*International Harvester Co., Memphis Works, Memphis, Tenn. (Ed Boywid, Fdry. Supt.).
R. W. Huston, Manufacturing Engr., Westinghouse Electric Co., (Trafford Foundry) Trafford, Pa.
H. R. Kohl, Fdry. Supt., C. I. Capps Co. Inc., Jacksonville, Fla.
John O'Meara, Student, Met. Engrg., Carnegie Institute of Technology, Pittsburgh, Pa.
J. V. Westwood, Student, Kansas University, Lawrence, Kansas.

Argentina

Arturo F. A. Acevedo, Asst. to Pres., "Acindar" Industria Argentina De Aceros, S.A.

England

F. W. Bates, Messrs. Newton Chambers & Co. Ltd., Thorncliffe, Nr. Sheffield.
G. L. Jones, Foundry Engr., The International Meehanite Metal Co. Ltd., Westminster, London.
R. Lorasig Larsen, The International Meehanite Metal Co. Ltd., Westminster, London.

India

J. S. Gupta, Junior Fdry. Fore., Locomotive Central Workshops, Ajmer.

* Company Members

CHAPTER ACTIVITIES NEWS

Central New York

John A. Feola
Crouse-Hinds Co.
Publicity Chairman

"NATIONAL OFFICERS' NIGHT," held April 9 at the Onandaga hotel, Syracuse, was attended by A.F.A. National President Max Kuniansky. R. A. Minnear, chapter chairman, presided and introduced Mr. Kuniansky to 110 members and their guests.

Mr. Kuniansky complimented the chapter on its activities and briefly outlined the work being done by A.F.A. in providing technical data for use in various sections of the industry.

Chairman Minnear then introduced the principal speaker, Thomas Curry, metallurgist, Lynchburg Foundry Co., who spoke on "Chemically Bonded Sands."

Mr. Curry covered the work done by his company in the development of chemically-bonded sands, explaining its advantages and disadvantages and some of the steps taken to overcome the latter. He presented a number of slides showing the various types of castings made by his company, using this sand, and pointed out the improvements in each that were directly attributable to chemically bonded sand.

Mr. Kuniansky presided over the discussion period following Mr. Curry's talk.

Mr. Kuniansky concluded the meeting with a description of the purposes and accomplishments of A.F.A. Present membership numbers over 10,000, he said, and is divided into 40 regular chapters and five student chapters. He added that it is from these student chapters and other A.F.A. educational programs that foundry owners and managers will draw their key personnel in the future.

In addition to the regular evening program, the chapter invited local foundry owners and managers to a luncheon meeting.

Cincinnati District

C. H. Fredricks
Cincinnati Milling Machine Co.
Chapter Reporter

A.F.A. NATIONAL PRESIDENT Max Kuniansky was guest of honor at "National Officers' Night," held at Engineering Society Headquarters, March 9.

Mr. Kuniansky outlined the work A.F.A. is now doing and gave members a preview of future projects.

Thomas Curry, Lynchburg Foundry Co., Lynchburg, Va., delivered the meeting's technical address, "Chemically Bonded Sands," in which he cited the successful use of chemically treated sand by his own company. The principal advantages, according to Mr. Curry, are better shakeout, i.e., shakeout sand in better shape for remixing, refuse sand limited to pins of core butts, and better casting finish; and toughness or strength at low moistures with good flowability—reduced metal penetration, more accurate overall dimensions, deep and intricate lifts possible on both cope and drag, with few stickdowns.

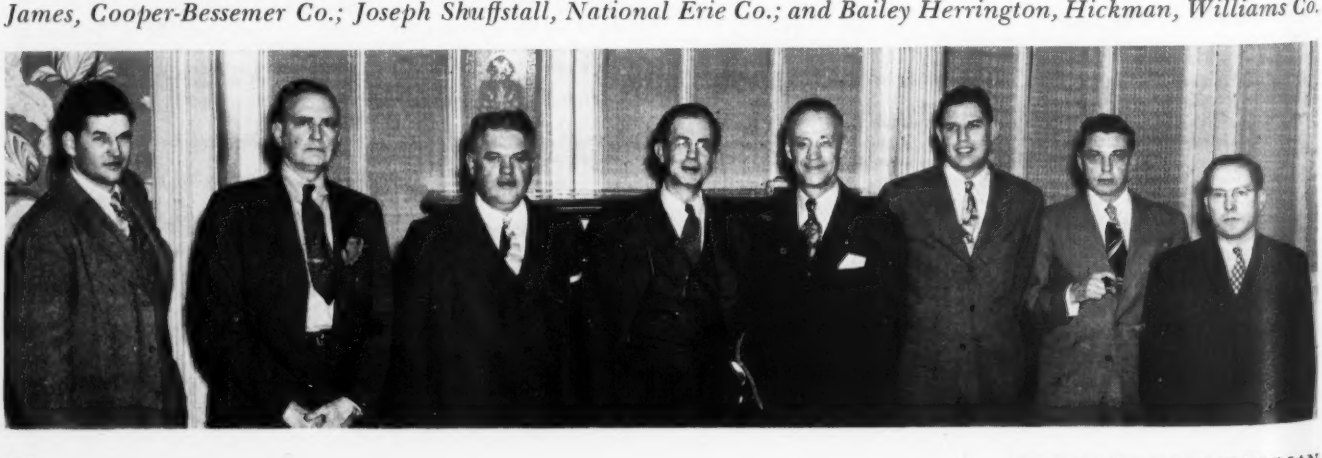
Mr. Curry also cited reduction in cleaning costs and preparation time and materials; extended range of castings in one sand; and improved condition of sand handling equipment. The cost of chemically bonded sand, he added, is comparable to that of synthetic sand mixes.

Western Michigan

Charles Cousineau
Lakey Foundry & Machine Co.
Chapter Chairman

MORE THAN A HUNDRED members and guests heard U. S. Sullivan, Caterpillar Tractor Co., Peoria, Ill., speak on "Inspection of Rough Castings from a Consumer's Point of View." Mr. Sullivan is in charge of inspection of all rough castings purchased and produced by Caterpillar and spoke with the authority that such a position implies.

At the speakers' table at the February meeting of the Northwest Pennsylvania chapter are, left to right: Jack Gill, Lake Shore Pattern Works; Harry Gebhart, United Oil and Manufacturing Co.; John Clarke, General Electric Co.; Ralph Lee, General Motors Corp., principal speaker; Tom Beaulac, Chicago Pneumatic Tool Co.; Douglas James, Cooper-Bessemer Co.; Joseph Shuffstall, National Erie Co.; and Bailey Herrington, Hickman, Williams Co.



Mr. Sullivan discussed the increasing demands being made on the foundry industry by the consumer in regard to finish, tolerance and clearance, and explained how these demands will affect foundry inspection techniques.

Mr. Sullivan stressed an important and controversial point—the tendency of consumers to omit essential information on their blueprints. He emphasized the omission of such helpful items as places for pattern numbers and trade marks, finish and layout points. Mr. Sullivan said that his company is gradually remedying these omissions and that other consumers should also make an effort to cooperate in every way with foundries.

Texas

W. H. Lyne
Hughes Tool Co.
Publicity Chairman

E. E. BALLARD, CHIEF ENGINEER, Development and Installation Division, Lester B. Knight Associates, Inc., addressed the March 19 dinner meeting, Houston, on "The Modern Foundry — Design, Operation and Maintenance."

Mr. Ballard pointed out that any improvement program should either be designed to increase capacity or decrease costs. Existing equipment should be fitted into the plan, with new equipment added to balance the capacity of each department, he stated, emphasizing the important part that materials handling plays in this balancing operation. He cited the example of a foundry that decreased man hours 33⅓ per cent and increased tonnage 50 per cent as the result of such an operation.

A modernization program should first be worked out on paper, then discussed by management, operating and maintenance personnel, before acceptance. Such a program should pay for itself within three to five years, Mr. Ballard stated, adding that if the capital expenditure is large and the capital is small, the program can be worked out in a series of installations.

Mr. Ballard cited good housekeeping and regular inspections as important factors in plant modernization, and particularly stressed an adequate safety program.

Maintenance is also highly important, Mr. Ballard added. Competent mechanics with adequate equipment are a necessity, as are frequent inspections and an efficient record system. He stressed the use of preventive maintenance as a cure for lost man hours due to breakdown of equipment.

Robert E. Cameron, Webstet & Sons, Ltd., center, and O. L. Voisard, Robert Mitchell Co., Ltd., listen attentively to A.F.A. National Vice President W. B. Wallis as he outlines A.F.A.'s current activities and future plans at the March meeting of the Eastern Canada & Newfoundland chapter, Montreal.

Eastern Canada & Newfoundland

H. E. Francis
Jenkins Bros., Ltd.
Chairman Publicity Committee

NATIONAL OFFICERS' NIGHT, held at the Mount Royal hotel, Montreal, March 12, featured an address by A.F.A. National Vice President W. B. Wallis, who spoke on A.F.A. promotion in industry, at a Director's Dinner, preceding the regular chapter meeting.

During the evening there were two talks by the winners of the Chapter's Technical Papers contest. Co-winner of first prize Paul von Colditz, Canadian Car & Foundry Co., Ltd., presented his paper, "Thermit Pipe-Eliminator for Steel Castings." This was followed by the other first-prize paper, "Immersion Thermocouple for the Iron Foundry," presented by A. H. Lewis, Dominion Engineering Works, Ltd., co-author with C. A. Sebistianowitch, also of Dominion Engineering. Both talks were illustrated.

Nominations for chapter officers and directors for the 1948-1949 season are as follows: *chairman,* O. L. Voisard, Robert Mitchell Co., Ltd.; *vice chairman,* James H. Newman, Newman Foundry & Supply Co., Ltd.; *secretary,* J. G. Hunt, Dominion Engineering Works, Ltd.; *treasurer,* L. Guilmette, Canadian Foundry Supplies & Equip., Ltd.

Directors (terms expire 1949): C. C. Brisbois, Montreal; W. J. Brown, Robert W. Bartram, Ltd.; and H. E. Francis, Jenkins Bros., Ltd.

Directors (terms expire 1950): Rene Belisle, J. A. Gosselin Co., Ltd.; W. E. Hillis, Hillis & Sons, Ltd.; James Grieve Dominion Engineering Works, Ltd.; M. A. Hughes, LaSalle Coke Co.; W. Turney Shute, Canadian Car & Foundry Co., Ltd.

Directors (terms expire 1951): Lucien Beaudry, Warden King, Ltd.; H. T. Doran, Whiting Corp. (Canada) Ltd.; A. Jack Moore, Montreal Bronze, Ltd.; J. E. Roberge, Hardware & Woodenware, Inc.; Alex Watson, Canadian National Railways (Foundry).

Chicago

V. M. Rowell
Velsicol Corp.
Chapter Secretary

OFFICERS AND DIRECTORS of the Chicago chapter nominated for 1948-49 at the April 5 meeting are:

Chairman, C. K. Faunt, Christensen & Olsen Foundry Co.; *vice chairman,* W. D. McMillan, International Harvester Co.; *secretary,* Victor M. Rowell, Velsicol Corp.

Directors (terms expire 1949): J. C. Gore, Werner G. Smith Co.; D. H. Lucas, manufacturers' representative; H. K. Swanson, Swanson Pattern & Model Works; Chester V. Nass, Pettibone Mulliken Corp.

Directors (terms expire 1950): George W. Anselman, Goebig Mineral Supply Co.; W. B. George, R. Lavin & Sons, Inc.; Robert M. Jones, Carnegie Illinois Steel Corp.; and

C. Drury, W .C. Clark, J. L. Leach and K. J. Trigger, all of the University of Illinois, are shown at the dinner preceding the Central Illinois ASM-A.F.A. meeting, held March 8 at the Jefferson hotel, Peoria.

Members and speakers attending the joint Central Illinois ASM-A.F.A. March meeting, Jefferson hotel, Peoria, are, left to right: A. V. Martens, Pekin Foundry and Manufacturing Co., A.F.A. chapter chairman; T. Logan, ASM chapter chairman; E. J. Wellauer, Falk Corp., Milwaukee, technical speaker; and A. W. Johnson. ASM, technical chairman.

Laurence H. Hahn, Sivyer Steel Casting Co.

Directors (terms expire 1951): Roy Frazier, Love Bros., Inc.; Alfred W. Gregg, Whiting Corp.; Martin Rintz, Continental Foundry & Machine Co.; and Fred B. Skeates, Link Belt Co.

Central Michigan

C. C. Sigerfoos
Michigan State College
Chapter Vice Chairman

THE CENTRAL MICHIGAN CHAPTER, meeting at the Schuler Hotel, Marshall, March 23, featured as speaker of the evening, George Tubich, district engineer for the Michigan Dept. of Health, who spoke on "Foundry Health Hazards."

Mr. Tubich, in stressing A.F.A. principles of making the foundry a good place to work, fixed the responsibility for good working conditions primarily upon management, which must not only be sympathetic to bettered conditions, but must sell the idea to supervision, which in turn must sell the idea to workers.

He added that the campaign to combat prejudice against foundry work must not only be carried to the public but must be waged in the industry itself, with top management leading the way.

Regarding competition, Mr. Tubich said that in most industrial areas the wage rates are usually equalized but there is still a basis for keen competition in the matter of a better place to work, and it is up to management to provide it.

Mr. Tubich concluded with a discussion of the principles of good ventilation and presented a series of lantern slides showing good and bad working conditions with regard to dust control, sanitation, illumination and medical care.

Central Illinois

V. W. Swango
Caterpillar Tractor Co.
Acting Secretary-Treasurer

E. J. WELLAUER, supervisor of Research, Falk Corp., Milwaukee, presented an interesting talk on "Welding Process in the Manufacture of Steel Castings" to a joint meeting of the ASM and A.F.A., held at the Jefferson hotel, Peoria, March 8.

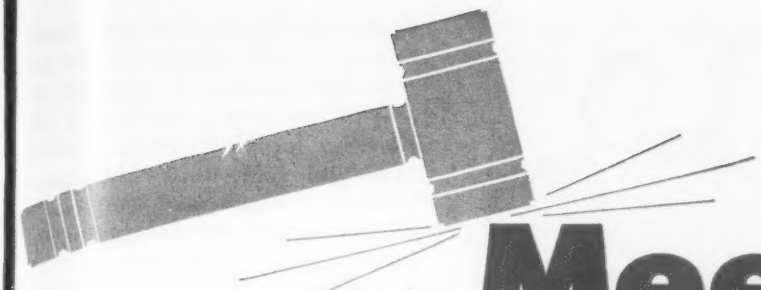
Mr. Wellauer's address, illustrated with slides, was divided into three topics, one mainly for metallurgists, one for designers, and one for engineers. In discussing the most economical methods of manufacturing various types of machines, and in comparing welded steel plate, steel plate welded to steel castings, and steel castings alone, Mr. Wellauer stated that each piece of equipment must be considered on its own design and that there is no set rule for choosing the more economical method. Mr. Wellauer illustrated his talk with slides of graphs showing results of testing various types of welding rod on different parent materials.

Chesapeake

Jack H. Schaum
Naval Research Laboratory
Chapter Reporter

AT ITS MARCH MEETING the chapter had as its guests members of the Baltimore chapter of the ASM. L. W. Eastwood, Battelle Memorial Institute, Columbus, O., guest speaker, delivered an address on "Casting Unsoundness Caused by Gas Evolution."

Mr. Eastwood pointed out that there are two types of gas evolution —one caused by a sharp drop in solubility for H_2 and O_2 when metal changes from liquid to solid—and the second a result of the formation of steam, CO, SO_2, etc. Only .000022 per cent H_2 dissolved in molten metal can form 1 per cent voids during solidifications. The reaction between H_2 and O_2 to form steam dose not take place in magnesium or aluminum alloys. Two types of porosity mentioned by Mr. Eastwood are pin hole, or gas, porosity and microporosity.



Chapter Meetings

MAY 19

TOLEDO
Toledo Yacht Club
COMPLETE REPORT OF CONVENTION

MAY 20

TWIN CITY
Covered Wagon, Minneapolis
KENNETH H. PRIESTLEY
Vassar Electroloy Products, Inc.
"Properties and Control of Electric Furnace Iron"

DETROIT
Engineering Society of Detroit
M. T. BEAN
Continental Aviation & Engineering Co.
"Simplified Casting Design"
BUFFET SUPPER

MAY 21

TIMBERLINE
Oxford Hotel, Denver
DR. JAMES T. MACKENZIE
American Cast Iron Pipe Co.
"Engineering Properties of Cast Iron"
JOINT MEETING WITH ASM

TRI-STATE
NATHAN JANCO
Centrifugal Casting Machine Co.
"Centrifugal Castings"

MAY 22

NO. ILLINOIS-SO. WISCONSIN
Beloit Country Club
ANNUAL PICNIC

MAY 24

CENTRAL INDIANA
Athenaeum, Indianapolis
DR. RALPH L. LEE
General Motors Corp.
"The Science of Humanics"

NORTHWESTERN PENNSYLVANIA
Moose Club, Erie
FRANK G. STEINEBACH
Penton Publishing Co.
"Recent Developments in the Foundry Industry"

MAY 25

CENTRAL MICHIGAN
Schuler Hotel, Marshall
HARRY W. DIETERT
Harry W. Dietert Co.
"Casting Defects and Their Remedies"

MAY 26

SOUTHERN CALIFORNIA
Rodger Young Auditorium, Los Angeles
DR. JAMES T. MACKENZIE
American Cast Iron Pipe Co.
"Cupola Practice"

MAY 28

CHESAPEAKE
Engineers Club, Baltimore
CLYDE A. SANDERS
American Colloid Co.
"Foundry Sand Practice"

JUNE 11

SOUTHERN CALIFORNIA
Rodger Young Auditorium, Los Angeles
MR. IRA MORGAN WHITE
Pelton Water Wheel Co.
"The Grand Coulee Pumps"

JUNE 12

TOLEDO
Twin Towers, Mich.
ANNUAL PICNIC

JUNE 16

CENTRAL NEW YORK
Montour Falls, N.Y.
Shepherd-Niles Crane & Hoist Co.
PLANT VISITATION
ANNUAL BUSINESS MEETING & OUTING

JUNE 19

PHILADELPHIA
Langhorne Country Club
ANNUAL OUTING

JUNE 25

NORTHEASTERN OHIO
Pine Ridge Country Club
STAG OUTING

Twin City

O. J. Myers
Werner G. Smith Co.
Chapter Reporter

E. V. BLACKMUN, chief works metallurgist, Aluminum Company of America, Cleveland, O., was the guest speaker at the April 1 meeting.

Mr. Blackmun started off his speech by taking the audience on a trip through a "phantom foundry" of the not-too-distant future. The "phantom foundry" gets its name from the ghostly appearance it presents to the visitor, he said. Metal is poured, and castings made and knocked out with no one in sight.

This "push-button" foundry, in which labor is kept at an absolute minimum, is similar to an eerie freight-marshaling yard, wherein the castings are the freight cars. A huge panel board, sparkling with red, green, yellow and white lights, directs the castings along a maze of monorail conveyor tracks. All this is done by one employee, who merely pushes buttons and closes switches, Mr. Blackmun said.

The production of any foundry depends upon three major factors, Mr. Blackmun said. These factors are (1) equipment, (2) material, (3) workmanship. He did not go into the problems of equipment or workmanship but went into some detail about control of materials.

In speaking of aluminum, Mr. Blackmun stated that it must be handled differently from other metals, because of its hydrogen absorption and affinity for oxygen.

Its hydrogen absorption causes porosity and may best be handled through diligent melting practices.

The waste of metal caused by oxygen is exemplified by the tons of dross produced in aluminum factories. It is not unusual, he added, to have 6 per cent of the metal melted lost in dross—representing from 12 to 14 per cent of the weight of cleaned castings shipped from the factory. Most dross is caused by too many metal transfers. Less handling of metal means more economical production through reduction in dross.

Aluminum foundries are tending toward synthetic molding sands having high green strength together with adequate flowability, according to Mr. Blackmun. The use of a synthetic mixture allows permeabilities in excess of 30 to be used without sacrificing casting finish.

Shown grouped around the Philadelphia chapter's "Non-Ferrous Night" speaker, Alfred M. Bailey, director of the Colorado Museum of Natural History (center) are, left to right: Chapter Chairman E. C. Troy, National Engineering Co.; G. H. Clamer, Ajax Metal Co.; W. B. Coleman, W. B. Coleman & Co.; and C. L. Lane, Florence Pipe & Machine Co.

The new group of aluminum alloys developed from war materiel scrap will be the most common alloys of the future, he concluded.

The meeting closed after a spirited discussion of aluminum foundry problems.

Central Ohio

H. W. Lownie, Jr.
Battelle Memorial Institute
Chapter Reporter

"CASTING DEFECTS," given by W. B. McFerrin, Electro Metallurgical Co., Detroit, was the principal address of the March meeting.

Mr. McFerrin pointed out the terrific monetary value of castings scrapped every year by the foundry industry and estimated that a reduction in scrap of one per cent over the industry would result in savings of $25 million annually.

Typical casting defects were shown by a series of slides and the factors responsible for each were discussed. Metal pouring was shown to be a major contributing factor to many types of scrap.

Management has an important responsibility in reducing scrap, Mr. McFerrin added, citing "buck passing" and inadequate planning by management as the major causes of the large amounts of scrap produced by foundries. More definite action and a more realistic management viewpoint could be expected to reduce scrap losses materially at many plants.

Mr. McFerrin illustrated the value of adequate training with examples of castings made at three different types of foundries. A relatively old-fashioned jobbing shop produced 18 per cent scrap on the job, a good production foundry had 7 per cent, and a new, well-designed plant under progressive management made the same job with 3 per cent scrap. The difference between these scrap figures was due almost entirely to the amount of thought given the problem by management and the amount of training of employees. Joseph A. Park, Dean of Men, Ohio State university, himself a former foundryman, entertained with a coffee talk, concluding the meeting.

Members and speakers attending the March meeting of the Central Ohio chapter are, left to right: Norman Dunbeck, Eastern Clay Products Co., A.F.A. national director-elect; Fred Fuller, National Engineering Co., chapter vice chairman; W. B. McFerrin, Electro Metallurgical Co., Detroit, principal speaker of the evening; Dean Joseph A. Park, Ohio State University, "coffee talk" speaker; and Ray Frank, Bonney-Floyd Co., chapter chairman.

Philadelphia Chapter

Jack Furey
Swan-Finch Oil Corp.
Publicity Chairman

THE PHILADELPHIA CHAPTER held its annual meeting, "Nonferrous Night," at Franklin Institute, March 12, with Alfred M. Bailey, Director, Colorado Museum of Natural History, Denver, as the dinner speaker. Dr. Bailey's illustrated lecture and motion picture, "Mormon Land," told the story of Utah's early explorers, the settling of Salt Lake City by the Mormons, and depicted the picturesque Zion and Bryce Canyons.

Climax of the film was a boat trip down the San Juan and Colorado rivers and a visit to Monument Valley and the Navajo Indian reservation.

The February meeting, held February 13 at the Engineers' Club and attended by more than 150 members, featured Werner Finster, metallurgist, American Chain and Cable Co., Reading (Pa.) Foundry Division, as guest speaker. Mr. Finster's talk, "The Value of Simple Controls in the Foundry," covered the major operations of successful foundry management.

Michiana

S. F. Krzezewski
American Wheelabrator & Equip. Corp.
Chapter Reporter

THE MICHIGAN CITY members of the chapter acted as hosts at the final meeting of the 1947-1948 season, held at the Spaulding hotel, Michigan City, April 6. Motion pictures were shown following the dinner.

Announcement was made by Howard Voorhees, Peru Foundry, chapter chairman, of the election of officers and directors for the 1948-1949 season, they are: chairman, K. A. Nelson, Chicago Hardware & Foundry Co.; vice chairman, John Rush, Elkhart Brass Manufacturing Co.; directors (terms expire 1951), E. S. Wegenke, Sibley Machine & Foundry Co.; A. E. Peterson, Oliver Farm Equipment Co.; John P. Jordan, Dodge Manu-

facturing Corp.; and H. A. Dunphy, The Dalton Foundries.

Retiring Chairman Voorhees expressed his appreciation and thanked all members for the support and cooperation extended him during his term in office. The new officers and directors were then formally presented to the chapter members.

Following the introduction, John Rassenfoss, research engineer, American Steel Foundries, East Chicago, Ind., spoke on "Fundamentals of Sand Behavior," illustrated with slides.

Outlining the history of sand behavior in the early '20's, the speaker analyzed the progress made up to the present time. His presentation included many slides showing comparative data on tests to determine control, quality and results. The actions of bentonite, clay, silica flour and other ingredients used in the preparation of sand were explained in detail.

With the adjournment of the meeting, attended by approximately 125 members, the activities of the chapter ended for the season and will be resumed in September. Meanwhile, new committees will be appointed and plans will be formulated for next season.

Quad City

C. R. Marthens
Marthens Co.
Chapter Secretary-Treasurer

T. E. BARLOW, Eastern Clay Products Co., addressed the March dinner meeting of the Chapter on "Chemically Bonded Foundry Sands." About 125 members and guests were present at the dinner, which was followed by a musical program and the technical session.

Southern California

Leo N. Wood
Triplett & Barton, Inc.
Chapter Reporter

MOLDING MACHINES must be given a fair chance if they are to do a proper job, Charles F. Scherer, general manager of the Davenport (Ia.) Machine and Foundry Co., stated at the March meeting.

Blasts must be suitable, sand handling must be adequate, conveyor systems, though not necessary, must be linked with the machine's operation, he said. Flasks must be tight and the right size for the machine.

Mr. Scherer favored the rollover type machine for general purpose casting. He warned specifically against back-drafts "which may get by when hand-molding methods are used, but will never get by on molding machines."

"Make it a rule," he said, "to give plenty of draft, but no backdraft."

Use of molding machines does not necessarily presuppose mechanization throughout a foundry, Mr. Sherer said. He indicated, however, that the greater the general foundry efficiency, the more successful castings will come from use of the proper machine.

Harry E. Kunkel, chief inspector of the Los Angeles County Air Pollution Control District, addressed the meeting on control and abatement of noxious fumes.

Many pointed questions were asked Mr. Kunkel by a dozen or more foundry owners who wanted to know methods of controlling smoke economically. To all such inquiries, Mr. Kunkel replied that the new "smog" law's teeth were ready to go to work but that the "know how" in air clean-up techniques had been left up to the individual plant owner.

There was smog in Los Angeles back in 1940, when there were only 1500 industrial plants in the area, it was brought out. Now with 7500 factories, smog is not much worse.

Victor Barton, vice president of Triplett and Barton, Inc., outlined the apprentice training program. Patternmaking classes, he said, are growing rapidly, but coremaking and molding students are harder to find and enroll.

Art Hageboeck, Frank Foundries Corp., Moline, Ill., left, poses with National Director-Elect Robert Gregg, Reliance Regulator Co., Alhambra, at the March meeting of the Southern California chapter.

Chapter President Henry E. Russill reported selection of this year's nominating committee for the state election: William Emmett, Robert R. Haley, Roy Nash, Arthur Lamb, J. W. Strube, and Pasquel Arpea.

President Russill paid tribute to Robert R. Gregg, first president and co-founder of the chapter, in reporting that Mr. Gregg has been nominated to a three-year term as national director of A.F.A.

(Continued on Page 136)

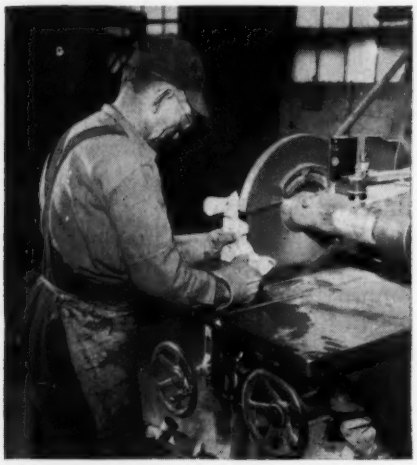
Charles F. Scherer, Davenport Machine & Foundry Co., Davenport, Ia., left, and H. E. Russill, Eld Metal Co., Ltd., chapter president, are shown at Southern California chapter's March meeting with the speaker of the evening, Harry E. Kunkel, Los Angeles Air Pollution Control District.

NEW Foundry Products

Readers interested in obtaining additional information on items described in New Foundry Products should send requests to Reader Service, American Foundryman, 222 W. Adams St., Chicago 6, Ill. Refer to the items by means of the convenient code numbers.

Cut-Off Wheel

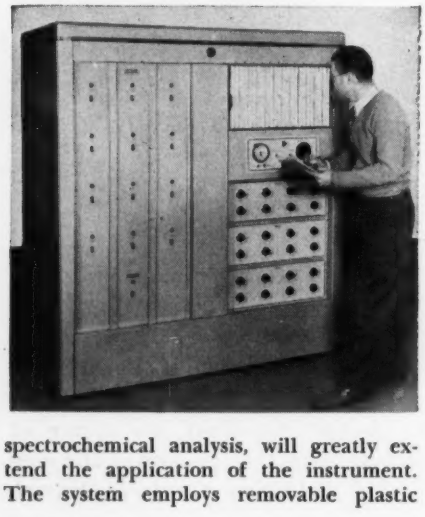
MY1—A reinforced type of cut-off wheel, the Norflex, is announced by the Norton Co., and is designed to meet the demand from non-ferrous foundries for a wheel that is tough, hard-to-break, fast-cutting and long-lived. Wheel can be twisted and



bent by the operator without breaking. Sides of the wheel present a unique file-like surface, which greatly enhances the wheel's cutting action. Concentric rows of molded teeth supplement the Alundum abrasive cutting grains in the periphery of the wheel.

Alloy Scales

MY2—A recording system to be applied to the Quantometer, Applied Research Laboratory's direct-reading instrument for



spectrochemical analysis, will greatly extend the application of the instrument. The system employs removable plastic panels fitted with direct-reading scales for each element being determined, and allows panels to be made up for each type of alloy. With this arrangement the instrument can be set up for the analysis of any alloy of a certain base metal within a few minutes.

Welding Helmet

MY3—A lightweight, low cost welding helmet, announced by Wilson Products, Inc., features a special-formula lens available in 12 shades. The helmet is made of one-piece vulcanized fibre, riveted at overlapping seams, and extends below the chin and over the ears for protection from hot metal. Adjustable headgear. Spring keeps helmet in raised position when not in use. Weight: 19 oz.

Mold Anchor

MY4—A mold anchor designed to eliminate the use of expensive offset plates has been developed by the Milwaukee Chaplet Co. After the pattern has been drawn and the mold is ready to be closed, one end of the mold anchor is pressed firmly into the sand of the drag until the center section lies flat along the parting line. As the mold is closed, the upper end is automatically pressed to the sand of the cone, securely locking the two parts in perfect alignment. Ordinary flat pattern plates can be used to produce the most particular castings without losses due to shifts. Available in ¾ in. and 1¼ in. widths.

Hacksaw Frame

MY5—A rigid hacksaw frame, featuring a one-piece steel tube back fitted into a precision machine-cast aluminum handle, is announced by the Machine Rebuilding Co., Detroit. Blade may be tightened to high tension, which maintains true alignment without twisting the blade, and lessens breakage and excessive wear. Frame does not collapse while blade is being installed and is adjustable for 10 in. and 12 in. blades. All steel parts are cadmium plated. Total weight is 22 oz.

Metal Saw

MY6—A heavy-duty metal cutting band saw, with automatic cutting cycle and electrically controlled blade pressure, announced by the Wells Manufacturing Corp., is available with a complete, self-contained Wells wet cutting system. The system, installed as an integral part of the saw includes a chip pan, fluid tank, centrifugal type pump-motor, splash guards and protective screens. The chip pan is mounted firmly between bed and base. Permits safe use of higher fpm cutting speeds and increases blade efficiency.

Tumblast

MY7—A continuous Wheelabrator Tumblast is announced by the American Wheelabrator & Equipment Corp. for high production blast cleaning. By utilizing a unique combination of tumbling and longitudinal travel of the work, the Continuous Tumblast offers thorough cleaning and uninterrupted efficiency. No time is lost for starting, stopping, loading and unloading, since parts are fed into and discharged from the machine in a continuous flow. Work to be cleaned is carried through the

blast barrel on an endless apron-type conveyor which constantly tumbles and cascades the pieces, completely exposing all surfaces to the abrasive blast from the overhead unit. Rate of progress is regulated by tilting the mill to proper angle by means of jack screws. Construction details are available in bulletin 4 A. Photographs sent on request.

Water Cooler

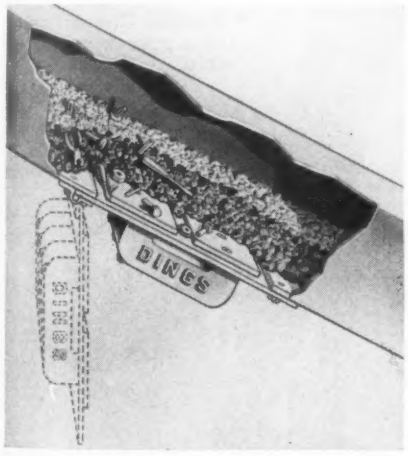
MY8—An electric drinking water cooler of sufficient capacity to meet the demands of foundry and shop workers is announced by the Ebco Manufacturing Co. Model OP-10W, the "Oasis" utilizes a water-cooled condenser, completely enclosed in heavy gauge galvanized and bonderized steel, and unaffected by room temperatures. Water is kept constantly at proper drinking temperatures.

Welding Gloves

MY9—Air Reduction Sales Co. has a welding glove of medium weight, chrome tanned cowhide with a one-piece leather back employing the wing-type thumb construction and fabric lined cuff. The wing-type thumb allows maximum thumb action without binding or pulling across the palm. The sturdy fabric cuff lining prevents sagging or crumbling.

Magnetic Separator

MY10—A line of permanent magnetic separators, known as "perma-plate" magnets, to remove tramp iron from materials traveling down chutes or through ducts has been developed by Dings Magnetic Separator Co. The magnets are intended for protection of grinders, crushers, stokers and other machinery susceptible to damage by iron. The magnets consist of a series of "C" shaped magnets, the poles of which are secured to steel plates and the entire assembly mounted on an aluminum plate. Installation is made by cutting away a section of the bottom of the chute and installing the magnet in its place. The magnet is mounted on hinges so that it can be swung away for removal of collected iron. The steel pole plate projects up from the



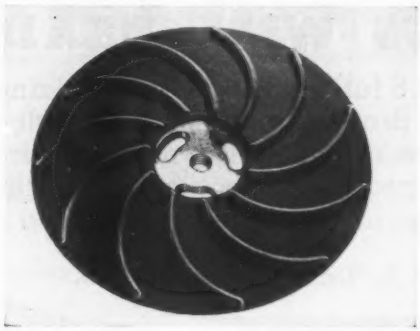
face of the magnet providing edges which help mechanically to arrest and hold the iron. Standard units are available in a range of sizes 4-in. to 72-in. wide in increments of two inches.

Nisiloy

MY11—Nisiloy, an alloy whose composition is essentially 60 per cent nickel, 30 per cent silicon, and 10 per cent iron, has been developed as an inoculating agent for gray iron to afford structural control for the improvement of machinability, it is announced by International Nickel Co. Since the nickel-silicon contents are in the eutectoid proportion, the alloy has a much lower melting point than either nickel or silicon, and lower than that of cast iron. Because of this, and because of the high specific gravity of Nisiloy, it penetrates and diffuses rapidly throughout the melt, avoiding any risk of floating and oxidizing into a surface scum or slag, and exerts a strong homogenizing influence on the product. In some instances, Nisiloy has eliminated the annealing necessary to permit efficient machining.

Disc Backing Pad

MY12—A backing pad made of layers of rubber reinforced with fabric and securely bonded to a slotted iron hub is announced



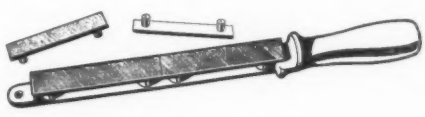
by the Pratt Manufacturing Co. Slots in the hub force air through to the back of the sanding disc, keeping it cool under severe usage, and keeps abrasives clean. Rubber pads permit great flexibility in working shapes without danger of gouging.

Protective Paint

MY13—A long-wearing synthetic paint with a corrosion-resisting surface that is capable of protecting floor and wall finishes in foundries and metal plants, is announced by Lowebco, Inc., Chicago. This free-spreading paint dries to a hard, durable glossy finish in three to four hours, seals concrete surfaces from moisture, resists acids, and expands and contracts with the material covered. According to tests, this paint resists 81 per cent more abrasion than similar types, resists sulphuric acid up to 50 per cent solution, nitric acid to 10 per cent, is immune to alkalies and caustic soaps. Heat resistance to 500 F. Forms a corrosion resistant, rust-proof finish that will not chip or peel.

Hand Files

MY14—Hand files of cemented carbide featuring ground teeth are available with either 20 or 30 teeth per inch and in ¾ in. or 1¼ in. widths, it is announced by Severance Tool Industries, Inc. Two tandem carbide segments are mounted in combination handle-holder, shaped to fit the hand, with thumb rest and knuckle guard. Severance ground carbide files will cut steels no other file will touch (up to Rockwell C 62), permitting many times faster filing speeds and enabling burrs to



be removed from steel parts while still revolving at carbide turning speeds. Carbide segments may be removed and returned to manufacturer for regrinding.

Stabilized Zirconite

MY15—Stabilized zirconite, a new material with an unusually high melting point and possessing excellent heat shock resistance, is announced by Titanium Alloy Manufacturing Co., Niagara Falls, N.Y.

Thermocouple Wire

MY16—A complete line of high-accuracy thermocouple wire for measurement of temperatures in industrial processes and laboratories is announced by General Electrics's Meter and Instrument Divisions. Upon request, thermocouples will be assembled from the new line of wire to meet requirements for most measuring applications. Two bulletins: GEA-4881, listing various types of thermocouple wires and insulation materials and applications; and GET-1415, giving output characteristics of common thermocouple wire materials, are available.

Departmental Truck

MY17—A departmental truck with a simple hook-length adjustment that enables it to handle an unlimited variety of small loads is announced by the Easy-Tote Products Co. By setting hook to required length, load may be engaged, easily cranked onto baseplate and automatically deposited over axle, at which point hook falls free. Single worker can handle loads up to 400 lb safely and without assistance. Semi-steel or rubber wheels optional. Low, 2 in. high baseplate with rounded front corners insures easy, safe loading. Three-wheel arrangement with rear swivel caster permits quick turns in crowded work areas.

Milling Mounting

MY18—A new-type, fully-universal "Rail Type" milling mounting, announced by Rusnok Tool Works, can be operated on either side of overarm or directly in front

of overarm and can be quickly and rigidly locked in any position within a full 180° adjustment. Brackets are available and custom-fitted to milling machines with round overarm within a 3 in. to 5 in. diameter range. Easily adaptable to any Rusnok milling attachment.

Sweat Band

MY19—A soft, sponge rubber perspiration retainer, developed by the Mine Safety Appliances Co., fits comfortably around the head and constantly absorbs perspiration, creating a cooling effect. The Cool-band may be thoroughly cleaned by hand-squeezing in soapy water and sterilized by the same method, using germicidal solutions. Bulletin CE-15 is avaliable.

THIS MONTH, 62,562* BUYERS OF CASTINGS WILL READ THIS AD...

This is one of a series of 6 full page ads emphasizing the expanding industrial acceptance of Brass Castings. Nationally circulated in outstanding trade journals and read by manufacturers, engineers, contractors, metallurgists, production control men—*these messages reach the men who specify and influence the purchasing of castings!*

R. Lavin & Sons, Inc.

ARCHITECTS AND BUILDERS AGREE

Bronze Ornaments Retain Their Lasting Beauty!

The beauty of Brass or Bronze ornamental works is inherent in the metal from which it is cast. The architect and builder know that there is no substitute for Bronze when lasting beauty is essential.

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BIRTHPLACE
of modern core binders

Here is where core oils are born and raised until they are ready to be graduated from the "lab" into foundries for practical test. Pictured below is a section of our modern foundry laboratory, equipped with all the latest devices for testing cores.

Here you'll find standard test ovens, dilatometer, hardness tester, compression strength machine, rammer, muller—everything needed to be sure that new developments in Hy-Ten Core Binders will be in line with foundry needs.

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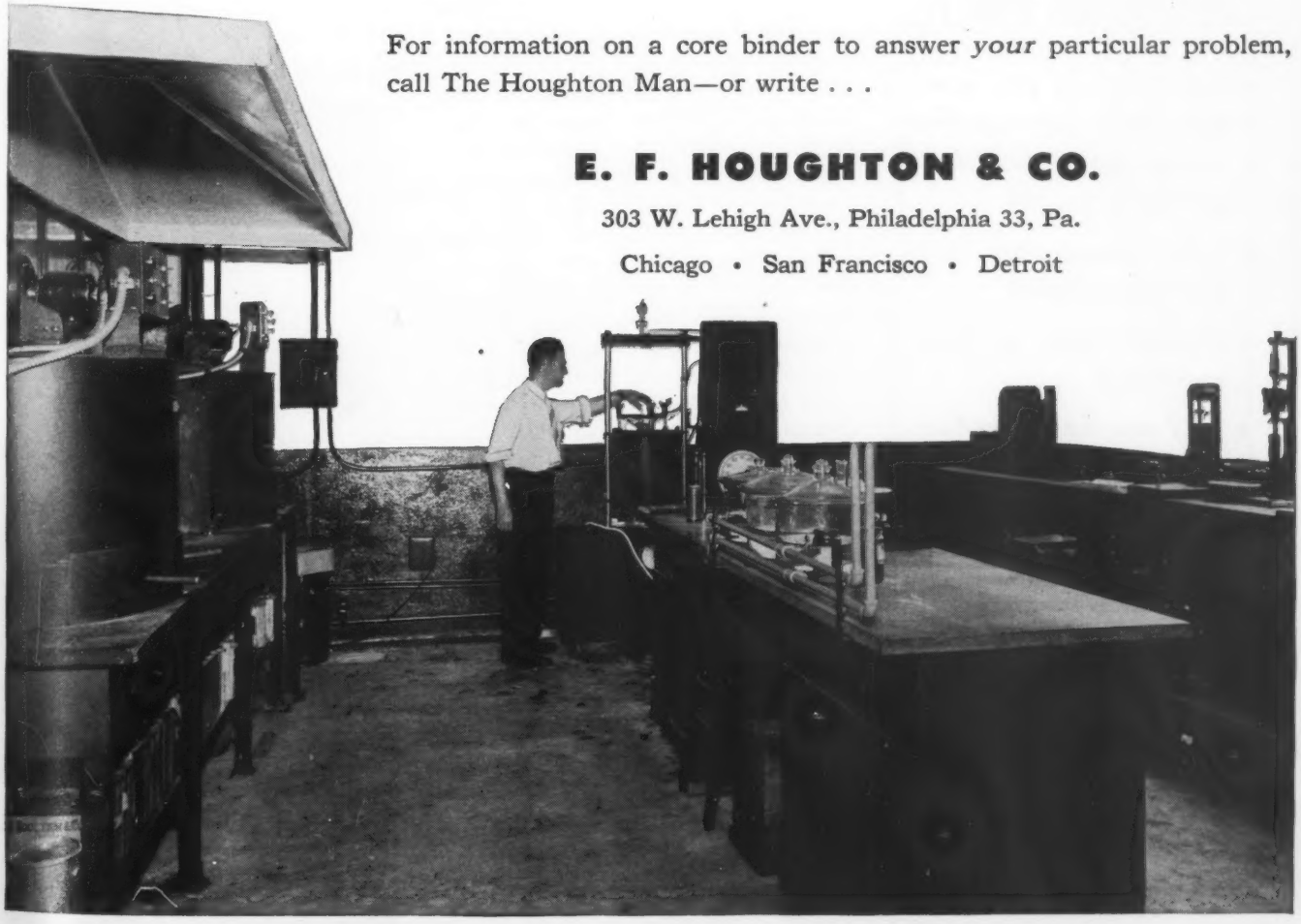

HOUGHTON'S HY-TEN CORE BINDERS

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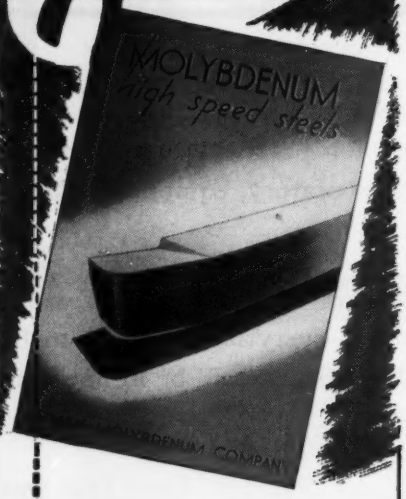

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CHAPTER ACTIVITIES

(*Continued from Page 131*)

Central New York

John A. Feola
Crouse-Hinds Co.
Publicity Chairman

BRUCE L. SIMPSON, president, National Engineering Co., Chicago, was the principal speaker at the March dinner meeting, held at the Onandaga Hotel, Syracuse.

Mr. Simpson's "History of the Foundry Industry," illustrated with slides, provided an interesting and educational evening. His talk started with the discovery, believed to be accidental, that metal could be melted and poured into a cavity to form a casting, in the Ural Mountains about 4,000 B.C.

Mr. Simpson pointed out that nations were successful commensurate with their interest in metallurgy, and as that interest failed, the nations lost their places as world powers. He cited the Chinese, Phoenicians, Egyptians, Greeks and Romans as examples.

Interesting facts were brought out concerning American history—Paul Revere was a foundryman and one of the original owners of the Revere Copper and Brass Co. Pig iron was one of the contributory causes to the Revolutionary War, because England demanded that all pig iron produced in the Colonies be shipped to the mother country for fabrication and prohibited its use in the colonies. Valley Forge was noted as a casting center and was burned by the British to prevent the manufacture of weapons for the Continental Army.

One of the most interesting slides showed molds being placed on conveyors and carried to pouring stations at a Westinghouse foundry in the 1880's, proving that mechanization was no innovation even then.

Chapter Chairman R. A. Minnear presided and introduced Mr. Simpson to the 90 members present.

No. Illinois-So. Wisconsin

Carl L. Dahlquist
Greenlee Bros. & Co.
Chapter Technical Secretary

A ROUND TABLE discussion divided into three sessions, was featured at the March 9 meeting, held at the Faust hotel, Rockford, Ill.

The first session, non-ferrous, was led by Upton Bartlett, Alloy Castings Co.; the second, gray iron, by Clarence Dale, Burd Piston Ring

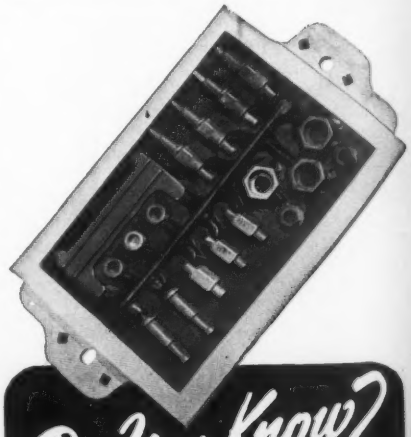
(*Continued on Page 140*)

"OLIVER"
2-INCH DOUBLE DISK
SANDER

for pattern makers

Has two tables 25"x12". Both tilt up to 45° down, 15° up. One table has 4" vertical adjustment, and is fitted with combination gauge for accurate sanding of segments and circles, and duplicating work. Machine is compact and rigid. Easy to adjust and run. *Ask for Bulletin 382.*

OLIVER MACHINERY CO.
GRAND RAPIDS 2, MICHIGAN



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This match plate solved a nuisance job... SAVED 400%

TAMASTONE
THE PERFECT PATTERN COMPOUND

Write! Learn how Tamastone can save in your plant

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The Illinois Clay Products Company is the leading producer of plastic fire clays and supplies the daily requirements of more than 300 foundries and steel plants.

Through specialization the Illinois Clay Products Company has long-established standards of quality. The large daily production assures dependable shipments and provides economies which make possible attractive savings to users of Fire Clays and Bond Clays.

Before reordering Bond Clay or Fire Clay, we suggest writing for full information and quotations on GOOSE LAKE and PEDRO Clays.

JOLIET — Illinois Clay Products Company — ILLINOIS

The GOOSE LAKE PLANT . . . largest of its kind. Located near Chicago, it is the most convenient source for midwest foundries and steel plants.

The Illinois Clay Products Company also operates a plant at PEDRO in Southeastern Ohio, where the well known Lawrence County Lower Kittanning Fire Clays are produced.

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- Heat resistant wooden soles
- Strong steel toe

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Wear a **Reece "Strong Toe."** Comfortable leather uppers. High, roomy steel toe protector, heat-resistant wooden sole. Have comfort-safe feet at work in oil refineries, foundries, steel mills, factories.

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The **Reece "Hot Foot" sandals.** Protect your feet in furnace and coke oven rooms. Straps on over your own shoes. Heat resistant wooden sole, strong galvanized iron counter, flexible hinge toe. Cannot slip.

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STANDARD HORSE NAIL CORPORATION
SINCE 1872
NEW BRIGHTON, PENNSYLVANIA

CHAPTER ACTIVITIES

(Continued from Page 136)

Co.; and pattern making by Ralph Lightcap, Rupp Pattern Co.

During the latter session, Mr. Lightcap stated that all core boxes should be rigged so that they can either be blown in the core blower or used on the bench.

It was mentioned that steel inserts of core blow boxes at the International Harvester Co. have been replaced by longer-wearing, less-abrasive plastic inserts. The European practice of lining core boxes with abrasive-resistant rubber and having a small sand-ingate and no vents in the corebox was reviewed. It was agreed that wood is still very satisfactory to use with core blowers.

Mr. Lightcap stated that he casts match-plates on edge and pours them statically, instead of using pressure. The method includes using a pop-off riser at the side and holding temperature of the metal between 800 F and 900 F at the point where the metal appears slushy. Parting line shrinkage was eliminated by using small chills at the juncture of pattern and plate.

It was also brought to the attention of purchasing agents that the patternmaker should be given ample time to produce the match plate to insure best workmanship.

The question was raised as to whether there could be a per-pound basis in the manufacturing cost of match plates and the findings were that there can be no successful per-pound basis established, due to the different construction of patterns.

R. D. Baysinger, superintendent, Greenlee Bros. & Co., asked about coating wooden core boxes with red crankcase sealer when converting a corebox to high production. Several patternmakers present replied that such a process was unhandy for commercial use because the sealer does not dry fast enough.

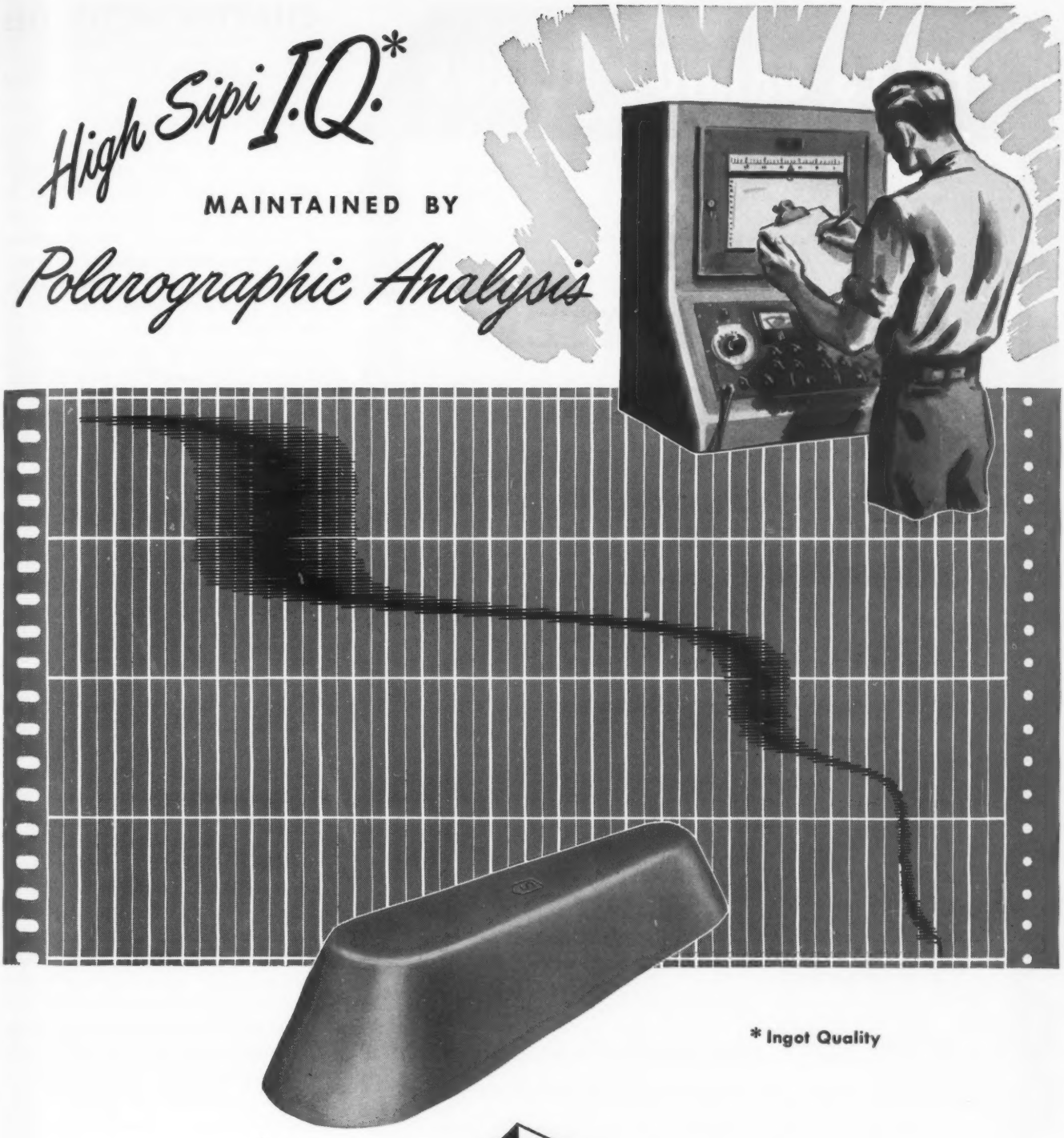
Bruce Whiting, Woodmanse Manufacturing Co., opened the gray iron session by asking, "What is a Shrink?" Chapter Chairman J. T. Clausen, Greenlee Bros. & Co., defined a shrink as the normal reduction in volume of the cooling metal. The factors that aggravate this reduction in volume by causing voids in the cooled metal—hot spots caused by oil in cores, and junction

(Continued on Page 144)

*High Sipi I.Q.**

MAINTAINED BY

Polarographic Analysis



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Our laboratory is available for information on our methods of using the Polarograph.

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Better castings result when "FALLS" SPECIAL PATTERN ALUMINUM is used:

...more fluid than other aluminum alloys, it will run thin sections more readily.

..."top shrinkage" is eliminated — no soldering to build up depressed areas.

...since heavy gates and risers are not needed, much extra casting expense is eliminated.

...with only a trifle less linear shrinkage than other aluminum alloys, no change in the pattern scale for running No. 12 Alloy is needed.

...checking is rarely encountered.

Write For Complete Details

NIAGARA FALLS
Smelting & Refining Division
Continental-United Industries Co., Inc.
BUFFALO 17, NEW YORK

CHAPTER ACTIVITIES

(Continued from Page 140)

points where thick and thin sections meet,—Mr. Clausen added.

It was generally agreed that a content of from 30 to 45 per cent steel in cast iron mixes increases the shrinkage factor, but can be counteracted by risering.

Another cause of shrinkage was explained as the expansion of sand close to the gate. Pouring temperatures, it was brought out, and directional solidification play a big part in causing shrinkage. Many shrinks are caused by lack of ferrostatic pressure.

Mr. Dale, moderator for the gray iron session, asked if anyone had had experience with Mexican or Texas pig irons. No one in the area seemed to have used Mexican pig iron but users of Texas pig iron described it as being of blast furnace origin and made from Texas ore and Oklahoma coal. Texas coke was also described, as being soft and small, of high sulfur content, and as having a normal carbon pick-up at 2750 F. The local company using it adds 10 per cent more Texas coke than other cokes, and uses a 30 in. raise on the bed with less splits.

Another member mentioned that he had had a difficult casting to make—a $\frac{3}{16}$ in. section with a large boss in the center that could not be reached with a riser. He was advised to have an iron mixture with less than 0.2 per cent phosphorus content, and to have a hard mold and to pour with very hot iron as fast as possible.

In the non-ferrous group discussion the pros and cons of cast iron versus aluminum were brought out by Mr. Bartlett in response to a question by Mr. Clausen. Mr. Bartlett stated that in some instances where lightness is desired and the manufacturer is willing to pay the extra premium, aluminum is preferable because of lesser shipping and cleaning costs.

J. N. Johnson of the J. I. Case Co. cited his foundry's experience with some supposedly aluminum bolts which would not melt. Mr. Hasselroth expressed the opinion that the bolts were of wrought aluminum, which is 90 per cent aluminum with a high magnesium content, plus copper and silicon.

It was agreed that there is no aluminum shortage at present, but that

the market is high. Hydroelectric power, used in the manufacture of aluminum ingots, is curtailed by droughts at present in the areas where most of the aluminum is produced. There is, however, a shortage of aluminum sheets due to builders' requirements.

Tennessee

A. D. Willis
United States Pipe & Foundry Co.
Secretary-Treasurer

THE FIRST MEETING of the Tennessee chapter was held March 26 at the Patten hotel, Chattanooga. Norman Dunbeck, Eastern Clay Products Co., guest speaker of the evening, addressed more than 100 members and guests on "Synthetic Sand Practice."

Mr. Dunbeck opened his talk by stressing the fact that in a new organization, such as the Tennessee chapter, attendance is the outstanding factor for successful operation.

In the course of his talk, Mr. Dunbeck elaborated on four fundamental questions: What is synthetic sand? How is it compounded? Who should use it? and How does a foundry make it pay?

Ontario

R. C. Tiplady
Canadian Metals and Metallurgical Ind.
Chapter Reporter

AT THE MARCH 26 MEETING, held in Hamilton, Ont., the following members were nominated to hold various posts in the chapter for the 1948-49 season: *chairman,* R. A. Woods, Geo. F. Pettinos (Canada) Ltd.; *vice chairman,* J. H. King, Werner G. Smith Co. Ltd.; *secretary-treasurer,* G. L. White, Westman Publications, Ltd.; *directors,* (to serve three years), Jack Richardson, United Smelting and Refining Co., A. C. Boak, Non-Ferrous Casting Co., and A. Reyburn, Massey-Harris Co., Ltd.

Immediate past chairman to serve on board for one year, J. Dalby, Wilson Brass and Aluminum Foundries. *Other directors (two year terms),.* Neil Kennedy, Wm. H. Kennedy & Sons, Ltd.; H. T. Wilson, Ontario Malleable Iron Co., Ltd., and R. H. Williams, Canadian Westinghouse Co., Ltd.; *(One year),* M. N. Tallman, A. H. Tallman Bronze Co., Ltd.; C. O. Flowers, Canada Iron Foundries, Ltd.; and A. E. Bock, Standard Castings.

Following the nominations, the regular monthly meeting was di-

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- CRATING LUMBER, in random lengths or cut to size.
- PALLETS, made to order...made to simplify your "moving" jobs.
- ROLLERS to make the movement of "big stuff" a simple operation.
- SKIDS, in special and stock sizes.
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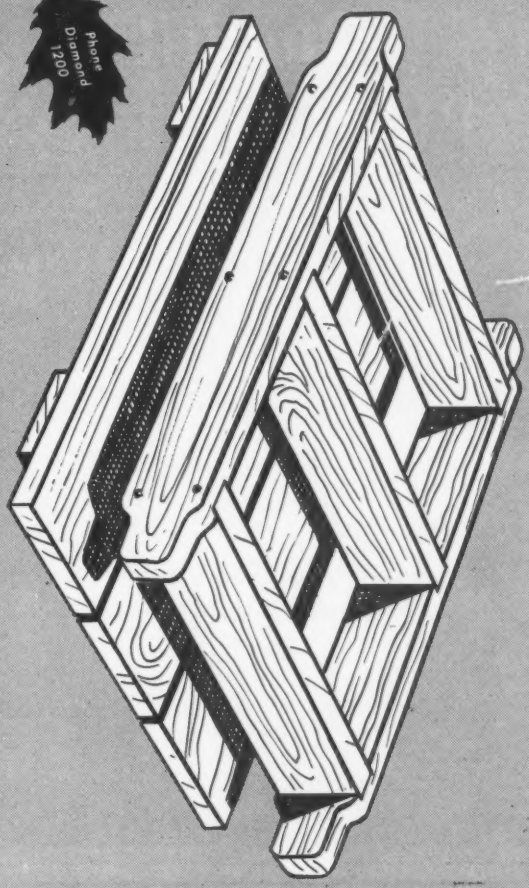

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ESTABLISHED 1866
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vided into three groups, with A. E. Bock as chairman of the Gray Iron and Malleable Iron groups; Harry Barnett, Welland Electric Steel Foundry, Ltd., chairman of the Steel group; and E. G. Jennings, Metals and Alloys, Ltd., chairman of the Non-Ferrous group.

Speaker of the evening, Lester B. Knight, president, Lester B. Knight & Associates, Inc., Chicago, addressed the group on "Modernization as Applied to Foundry Practice." Mr. Knight stressed study of the problem of housekeeping as the first step in foundry modernization, and as a means of avoiding over-mechanization. He quoted many instances wherein costs have been drastically reduced by carefully considering rearrangement of present equipment before large sums were spent on mechanization. He added that in the matter of plant layout very few foundries adopted the long-range view.

Another point to be considered, Mr. Knight said, is that of supervision. He pointed out that the war took away many men and that it has been hard to get supervisors who can instruct new personnel.

Mr. Knight showed many interesting slides selected from a survey his company has made of over 1500 foundries. These slides showed the perfect combination of mechanization and modernization and emphasized good foundry housekeeping.

He concluded by pointing out that each plant has its own problems and must be considered individually from the standpoint of modernization.

At the Non-Ferrous meeting, Edward Jennings, Metals and Alloys, Ltd., chairman, introduced the speaker, J. E. Lindsay, metallurgist, Light Alloys, Ltd., who spoke on "Light Alloys for Aircraft." He stressed the painstaking effort required to produce castings able to pass rigid aircraft inspection, and added that work is being done by Canadian foundries on jet-propelled engines which will be the equal of any in the world.

Central Illinois

V. W. Swango
Caterpillar Tractor Co.
Acting Secretary-Treasurer

DESIGNATED AS "National Officers' Night," the April meeting, held at the Jefferson hotel, Peoria, was attended by A.F.A. National

Vice President W. B. Wallis and National Director J. E. Kolb.

Mr. Wallis spoke on the growth and future plans of A.F.A. He was followed on the program by L. L. Clark, assistant foundry metallurgist, Buick Motor Co., the speaker of the evening.

Mr. Clark explained methods of charging and cupola practices at his plant, and illustrated his talk with slides. He stressed the importance of control in foundry operation and explained the use of a pure graphite block with a dry sand core for obtaining chill test specimens. This, he stated, gives a truer picture of the inoculants necessary than was formerly obtained with a water-cooled cast iron block, thereby making closer control possible.

Ed Roby, Peoria Malleable Castings Co., announced the following nominees for chapter officers for 1948-1949: chairman, F. W. Shipley, Caterpillar Tractor Co.; vice chairman, Charles Bucklar, Jr., Superior Foundry Co.; secretary-treasurer, Vern W. Swango, Caterpillar Tractor Co.; and three-year directors, E. J. Burns, Illini Foundry Co., and C. B. Soper, American Foundry & Furnace Co.

The annual clambake, it is announced, will be held June 12 at Keeneland Park, Peoria.

Southern California

Leo N. Wood
Triplett & Barton, Inc.
Publicity Chairman

FOUNDRY MECHANIZATION is the one answer to the vital problem of temperature control, according to Charles A. Barnett, Foundry Equipment Co., Cleveland, principal speaker at the February meeting.

Mr. Barnett reiterated the theme that good baking equipment for high temperature work often means the difference between success and failure in attaining final metal strengths. He pointed out that initial temperatures in baking may rise to 800 or 900 F before they can be brought down to desired levels, when using old-type furnaces.

With scientifically-designed apparatus, Mr. Barnett said, the foundryman can, for instance, bake a one-inch core one hour at 500 degrees, hold that heat for any desirable time consistent with optimum reaction on the finished casting. Alternately, he can heat to 400 degrees and again hold or diminish for any desired length of time, he stated.

Temperature tolerances can be controlled to within two or three degrees by use of mechanized equipment, he continued, while with the old-type apparatus close control is more a matter of luck.

Mr. Barnett employed slides to illustrate those phases of his talk which dealt with various types of mold drying furnaces, pit dryers and portable dryers.

Chapter President Hal Russill announced that apprentice class organization was proceeding successfully. Leonard Hoffstetter, Southern California Chapter vice president, introduced Mr. Barnett.

Connecticut Non-Ferrous

C. A. H. Knapp
Association Reporter

JOSEPH NIXON, foundry engineer, International Nickel Co., was the principal speaker at the March 17 meeting, held at the Hotel Taft, New Haven.

In speaking on "Producing Sound Brass and Bronze Castings," Mr.

THE MOST PROFITABLE REFRACTORY DATA YOU'LL EVER READ . . .

Here's the book that tells all about Buckeye Silica Firestone—gives comparative data and figures on its lower cost and greater efficiency. Foundrymen will be interested in the many pages devoted to results obtained from Buckeye in cupolas, ladles, etc. Interesting, too, are the testimonials from well known foundry executives. Send for your copy . . . it will be mailed immediately.

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Since 1879
FACINGS

BILL GAGGER *says:*

Reduces Chill!
Raises Carbon!

FERROGRAPH

An amorphous graphite readily absorbed by iron.

A graphitizer. Used as a ladle addition, it reduces chill.

A carbon raiser for malleable and steel furnaces.

Made in 3 sizes to fit your jobs.

MEXI-LUMP

Large sized lump, high carbon, amorphous graphite for cupola additions.

Just the type and size for quick carbon pick-up, during the pig iron shortage.

Write us for detailed information for using FERROGRAPH and MEXI-LUMP.

The Smith Facing & Supply Co.
1857 Carter Rd., Cleveland, Ohio

Nixon prefaced his remarks with the general statement that, in his experience, unsound castings were caused by gates which were too large and risers which were too small.

Mr. Nixon illustrated his talk with slides showing pieces of various designs, particularly 85-5-5-5 manganese bronze, 88-10-2 aluminum bronze, etc.

He said that it has been suggested that nickel replace part of the tin in certain alloys, because of metal shortages and high prices.

Mr. Nixon pointed out that if castings having bosses on top leak when risers are on the bosses, it is better to have risers on the side and feed directly.

Hot fed risers are better than dead risers, he stated, adding that strategic use of chills, when necessary, along with risers will materially help reduce unsoundness. Risers should feed castings at the heaviest section.

The speaker recommended large fillets on risers, strainer cores to keep back dross, the use of cores without extra oil on the surface as reinforcement, and the prevention of metal filling core vents.

In certain cases, Mr. Nixon said, ring gates with pencil gates therefrom are measures of economy and initiate directional solidification. Such pencil gates may be either on top of or under the casting.

A problem presented — handle castings which showed porosity under the skin after polishing. 85-5-5-5 metal melted in oil-fired crucible, with 1 oz phosphor-copper added, poured from a No. 18 crucible into a mold of No. 1 Albany sand at 6 per cent moisture. Metal melted under flux cover—¾-in. pouring sprue.

It was agreed to try the following to correct trouble:

Use sand of higher permeability and punch whistlers through at ends of castings where defect occurred.

Peen or tuck edges of mold and squeeze soft in center.

Superheat metal to 2250 and pour at 2175. Add 1 per cent zinc about 10 min before pouring and increase phosphor-copper additions to 2 oz per hundred to give residual phosphor of 0.009 per cent.

In case of trouble, fracture casting at point of defect to determine its nature. If burn-in occurs, silica wash, a lower clay content, or both, will often prevent it.

STEP THIS WAY!

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The simple Ōnox method of skin-toughening is used by thousands of the foremost industrial firms in preference to old-fashioned disinfectants.

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The choice of Foundries who demand the best.

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THE JACKSON IRON & STEEL CO.
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FIRM FACTS

Republic Steel Corp.'s recently-authorized by-product coke plant, to be constructed as an addition to its Warren, O., plant, will have 80 ovens and will cost an estimated $10 million.

Material Movement Industries, Inc., recently announced the removal of its general offices to the company plant at 9257 Laramie Ave., Skokie, Ill.

The Unitcast Corp., Toledo, O., announces the organization of a subsidiary, Canadian Unitcast-Steel, Ltd., and the subsequent purchase, by the subsidiary, of the Canadian Brake Shoe and Foundry Co., Ltd. The new company will manufacture railway equipment castings.

Several windows were broken and the roof of the building burned slightly recently at the **Owego Foundry,** Owego, Pa., when workers dumped molten metal onto snow. The flying hot metal started the fire on the roof.

The **Cahill Forge & Foundry Co.** was recently awarded the Gold Medal of the Chattanooga Safety Council for reducing plant accidents 69 per cent in 1947.

O'Dell-Norquist, Inc., purchased the Anoka (Minn.) Foundry and is revamping the plant for producing soil pipe and fittings.

Donovan, Inc., Winona, Minn., recently suffered a serious fire loss, with damages estimated at $35,000.

Proposal of the **Lake City Malleable Co.,** Cleveland, to purchase an Ashtabula, O., plant has now been approved by the Federal Government, according to information received from J. H. Redhead, president.

Philadelphia Coke Co., has awarded contracts for a new plant addition to cost $100,000 or more.

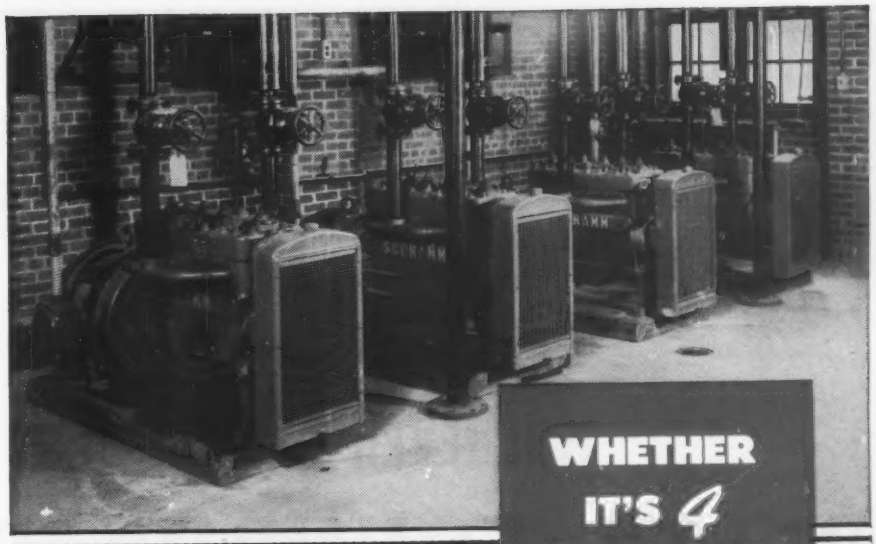
Monessen Foundry division of the **Rockwell Manufacturing Co.,** has acquired 1805 acres adjacent to its plant for the construction of a new addition.

Sparks from an overheated salamander recently caused fire damages amounting to $60,000 and destroyed half of the **Huron Gray Iron Foundry,** Ypsilanti, Mich.

Two new addresses of district sales offices of the **Whiting Corporation** are announced by R. S. Hammond, vice president. They are: Chicago District Sales Office, 33 South Clark St., Chicago; and Pittsburgh District Sales Office, 505 Liberty Ave.

A three-alarm fire that swept the block-square foundry of the **Crucible Steel Company of America,** Jersey City, N.J., completely destroyed the foundry, which was in the process of being dismantled.

(*Continued on Page 156*)



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Schramm Air Compressors can be easily installed as a unit system in plants requiring varying compressor loads and Schramm's Automatic Control makes it possible to operate them singly or in units as varying air requirements demand.

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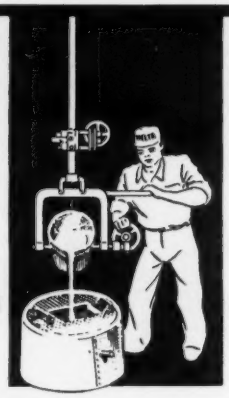

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Plastic-type Core & Mold Washes — for Steel Malleable, Grey Iron, Non-Ferrous Metals. *No-Vein Compound, Chillkoat, Spray Binders, Permi-Bond, Partex, Bondite, Mudding Compound, Core Rod Dip Oils, Sand Conditioning Oils, Pyro-Koat, Liquid Parting, Core Oils* and *Binders.*

Ask for a liberal working sample of any DELTA FOUNDRY PRODUCT for test purposes. You will also receive complete instructions for use.

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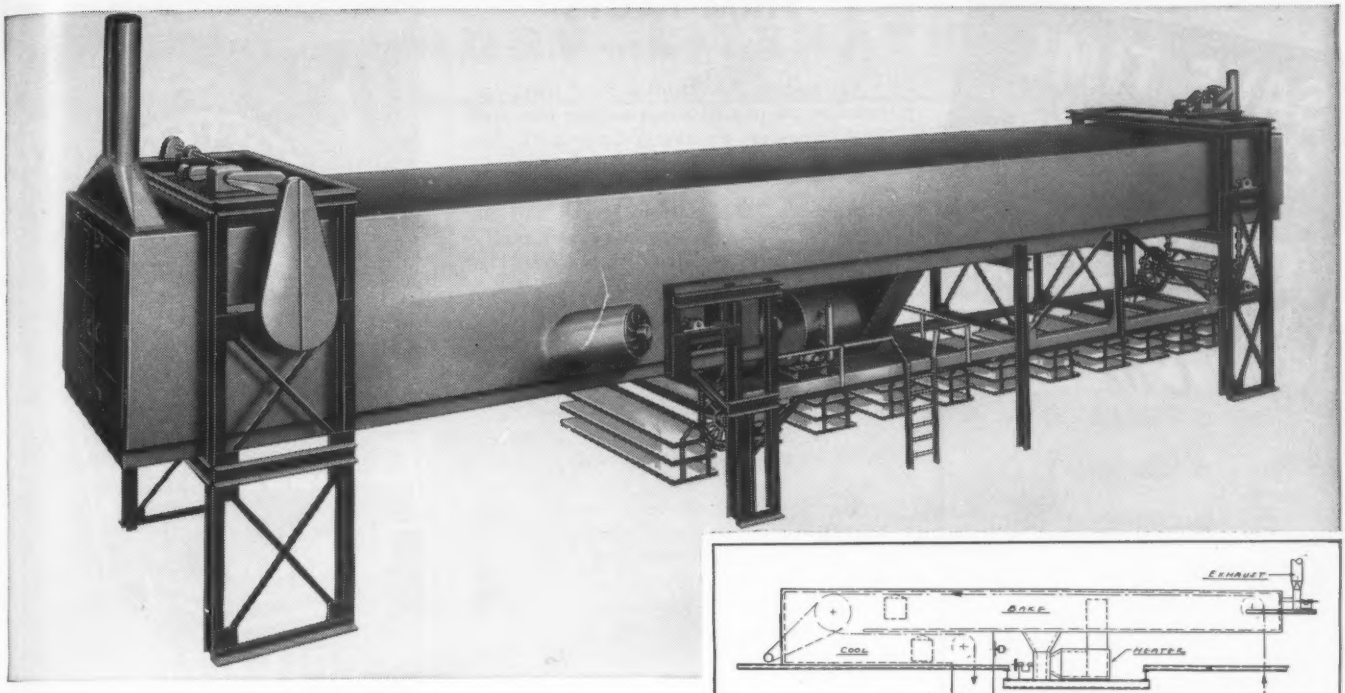

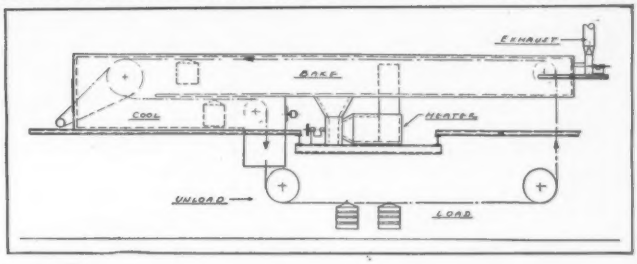

New HORIZONTAL CORE OVEN . . . . . offers many cost saving advantages!

The time-saving, space-saving, compact design of this new Horizontal Core Oven is characteristic of Young Brothers' Engineering. Into it went the skill and confidence of many years of experience . . . also a thorough knowledge of the job to be done and the production problems involved.

This new core oven can be installed in practically any building without making any major structural changes.

The coremakers are located right next to the oven so that they can load the cores directly on the moving racks thus eliminating the necessity of transporting them on hand trucks or a conveyor from the core room. The location of the coremakers, at the oven, also saves core room space.

The size of the loading racks can be varied and the shelves can be adjusted to accommodate cores of many sizes and shapes.

Besides allowing for the removal of exhaust gases at the point of greatest concentration, the new oven design provides an effective cooling zone for the cores and assures comfortable working conditions for the coremakers.

This New Horizontal Core Oven is Young Brothers' answer to the demand for better core baking equipment. It is YOUR answer to the need for lower production costs and higher operating efficiency.

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• You'll be amazed how quickly and easily you can cut virtually any special length or shape from the hardest masonry materials. Clippers save time — save material, assure better workmanship on every job.

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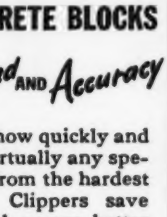
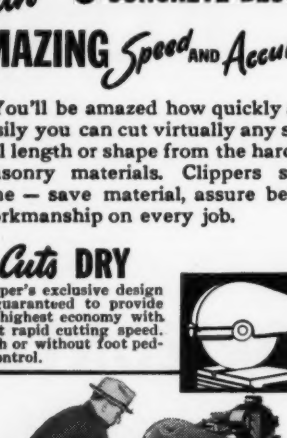
Clipper's exclusive design is guaranteed to provide the highest economy with most rapid cutting speed. With or without foot pedal control.





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No dust. With foot pedal control or without. You can set the cutting head in locked position. The hardest materials cut with ease.

FAST and FLEXIBLE

The New Model HD-48 Clipper cuts dry just exactly the same as regular Clipper Masonry Saws.. and for Dustless masonry cutting just turn on the circulating system and slice thru the hardest materials. Proven by ten years use throughout the world. Guaranteed to provide the fastest cuts with lowest cost.

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Yes . . . with a Clipper it's easy to slice thru Brick, Tile, Concrete, Glass, Marble, Porcelain or any kind of Refractories . . . Straight cuts, Angles or Mitres. CLIPPERS FOR EVERY JOB — Priced as low as $195. Write for Catalog Today!

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PHILADELPHIA CLEVELAND ST. LOUIS AUSTIN, TEX.

FIRM FACTS

(*Continued from Page 151*)

Adirondack Foundries & Steel, Inc., announces the purchase of a surplus iron and steel foundry at Watervliet, N.Y., for $257,000.

Manistee (Mich.) Iron Works had its second major fire in seven months January 17. Damage to the small parts foundry is estimated at nearly $100,000.

Yale & Towne Manufacturing Co. announces the consolidation of all its services in the Chicago area. The electric truck, hand lift truck and dial scale divisions will be quartered at the Railway Exchange Bldg., 80 E. Jackson Blvd., Chicago.

The Pyrometer Instrument Co., New York City, announces the completion of its new plant, laboratory and offices at Bergenfield, N.J. Effective March 15, all facilities of the company were moved to the new location.

Alten Foundry and Machine Works, Lancaster, O., was incorporated recently, according to an announcement by G. H. Alten, president and treasurer.

Wheeling Steel Corp. has completed arrangements for the installation of a large, low-purity oxygen plant at its Steubenville, O., steel mill. The oxygen plant will be installed and maintained by the **Linde Air Products Co.,** a unit of Union Carbide and Carbon Corp. The Linde plant will produce approximately 135 tons of oxygen per day to be used for metallurgical purposes, mostly in Wheeling's open hearth furnaces. The use of oxygen is expected to increase steel production.

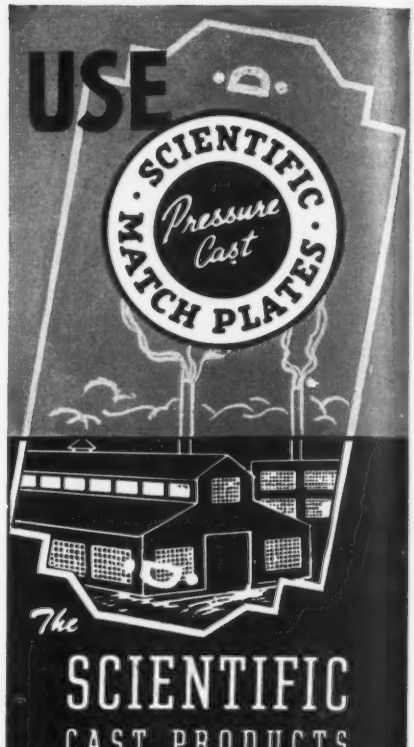
A corporation made up of local industrialists has taken over the **Dayton (Ohio) Foundry and Stove Works** for the installation of a foundry to manufacture gas heaters and stoves. The plant will be completely revamped and is expected to be in operation by July.

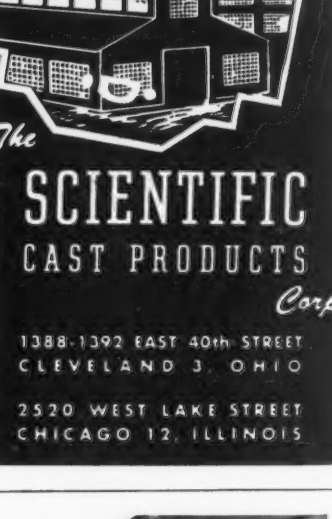
U. S. Pipe and Foundry Co., Chattanooga, Tenn., recently received a commendation from the Chattanooga Safety Council for its 1947 record.

Jones & Laughlin Steel Corp. will build a coal cleaning plant at its Nos. 4 and 5 coal mines at Vestaburg, Pa. The largest coal cleaning plant to be built by private capital, the new unit will produce 18,000 tons of washed coal daily.

Sam Tour & Co., Inc., New York engineers, metallurgists, and consultants, will expand its laboratories and workshops to occupy two-and-a-half floors of additional space in its building at 44 Trinity Place.

South Altoona Foundry of the Pennsylvania Railroad recently won top honors in the 1947 safety contest conducted by the railroad. This is the second successive year that the foundry has taken first prize in the maintenance of equipment division.





Foundry Sand Testing
HANDBOOK

A foundryman may select his scrap with the greatest of care. His melting procedure may check with the most advanced practice. And he may exercise full control over his methods. BUT . . . he cannot consistently produce sand castings in molds prepared from uncontrolled sand mixtures.

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222 W. Adams St., Chicago 6

• FOUNDRY LITERATURE •

MY100—"Carbon and Sulfur Analysis," a 12-page illustrated booklet recently released by the Harry W. Dietert Co., Detroit, lists the applications and specifications of the firm's products used in testing for carbon and surfur in both organic and inorganic materials. Included are combustion furnaces, oxygen regulators, carbon determinators, purifying trains, specimen molds, sulfur determinators and combustion tubes.

MY101—A 24-page, illustrated brochure recently released by Eastern Clay Products, Inc., shows the step-by-step methods by which Revivo Bond, Black Hills Bentonite and Dixie Bond are mined and refined.

MY102—"Die Slick for Casting Dies," a four page folder published by G. W. Smith & Sons, Inc., Dayton, O., outlines the general properties of the four grades of die slick available for die casting, die and machine lubrication, and recommends the specific grades to be used in producing zinc, aluminum, magnesium, brass or lead die castings.

MY103—Foundry Services, Inc.'s "Foundry Practice No. 89" features five articles: "Gravity Diecasting—Design of Simple Molds—No. 5"; "Further notes on the Manufacture of Chilled Cast Iron Rolls"; "Casting on a Sloping Bed"; "Iron Founding, Chapter 3, Part 1"; and "Denseners and Chaplets."

MY104—A 39-page catalog, No. 4748, covering Hapman Conveyors, Inc.'s line of pipe conveyors and accessories, includes engineering drawings of typical systems for flour, dust coal, sand, lead, chips, and sludge handling. Pictures and sketches illustrate drives, vibrator, sludge, tanks, trench, Pneumatrol and sealed pin chains.

MY105—A four-page circular describing in detail the functions and scope of the improved Sklenar reverberatory furnace is announced by the Sklenar Furnace & Manufacturing Co. This furnace utilizes an entirely new process for the melting of all kinds of metals. Photo-diagrams show principles of operation; tables show melting rates and capacities.

MY106—A comprehensive, 80-page "New Products" booklet recently published by the New York Journal of Commerce, lists more than a thousand new products and services gathered in a nationwide survey of manufacturers. More than 750 firms are listed in the compilation, together with detailed description of their new products.

MY107—A four-page illustrated bulletin recently released by Eberbach & Son Co. shows the company's complete line of redesigned metallographic polishing machines for laboratories, both floor and table models. Complete descriptions of specifications and applications are included.

FOUNDRY FILMS

MY108—Included in the U. S. Government films recently released are "Chemistry of Fire," a 46-minute adult vocational motion picture explaining fire, fuel, oxygen and ignition temperature. "Flue Gas Analysis," a 19-minute film, demonstrates how to make a chemical analysis of fuel gas to determine efficiency of combustion.

Readers interested in obtaining additional information on items described in Foundry Literature should send requests to Reader Service, American Foundryman, 222 W. Adams St., Chicago 6, Ill. Refer to the items by means of the convenient code numbers.

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Information contained in this important New A.F.A. publication has been compiled by the Recommended Practices Committee of the A.F.A. Brass and Bronze Division, and the Committees on Sand Casting of the A.F.A. Aluminum and Magnesium Division. A book that provides non-ferrous foundrymen with accurate, up-to-date data for the production of practically any non-ferrous alloy casting, and enables them to check present production practices against accepted standards and wide experience. An indispensable reference work wherever non-ferrous metals are cast . . . compiled by many leading foundrymen and metallurgists. Contains 159 pages, 42 tables, 35 illustrations; cloth bound.

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For the following alloys:

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OBITUARIES

Roland F. Smith, 45, vice president and general manager of the Waukesha Foundry Co., Waukesha, Wis., died April 4 after a prolonged illness. The son of the founder of the Waukesha Foundry, Mr. Smith began as an apprentice in 1922, becoming a member of the sales force in 1925, and sales manager from 1930 to 1939. During the war, Mr. Smith served on several industry advisory committees of the War Production Board. Mr. Smith was a member of the A.F.A., the NAM and several dairy associations, serving on the board of directors of the Dairy Industries Society, International.

George S. Trump, 57, chief technical superintendent of the aluminum plant of the Aluminum Company of America, died at his Watertown, N.Y. home, April 8. Mr. Trump had been with the company since 1921.

Donald W. MacDonald, 61, vice president of the Erie Foundry Co., Erie, Pa., since 1915, died March 19.

Dr. Thomas S. Gates, 75, chairman and former president of the University of Pennsylvania, died April 7 at his summer home on Cape Cod. He was a member of the board of directors of the Standard Steel Works, the Midvale Co., and the Baldwin Locomotive Works.

Lee A. Davis, 61, for over 40 years an employee of Oneida Foundries, Oneida, N.Y., died January 26. Mr. Davis was first employed by the now-defunct Munnsville Plow Co. and continued with the Sperry Foundry when it purchased the Plow Company. Both companies were predecessors of Oneida Foundries.

Alexander E. Gallipeau, 95, owner of a foundry at Mansfield, Mass., and formerly a veteran employee of the Shields Foundry Co., Mansfield, died February 10 at his home in Winchendon, Mass.

Herman H. Hossler, 57, vice president, Clio Foundry, Inc., Clio, Mich., died March 18. Prior to joining in the organization of the Clio Foundry in 1941, Mr. Hossler was a patternmaker with the Jackson and Church Co., and served as pattern shop foreman and foundry superintendent of Nelson Bros. Foundry, Saginaw, Mich., for more than 20 years. Mr. Hossler was a member of the A.F.A.

Harold A. Richmond, founder of the General Abrasive Co. and chairman of the board, died at his Niagara Falls, N.Y. home on April 8. Prior to 1916, when he founded General Abrasive, Mr. Richmond was associated with the American Emery Wheel Works.

Harry R. Schick, 63, general manager of the Jackson Iron and Steel Co., Jackson, O., died March 27 after a brief illness. Prior to joining the Jackson foundry 25 years ago, Mr. Schick served in a supervisory capacity with U. S. Steel Corp., Pittsburgh Steel Co., and the Bethlehem Steel Co.

• THE BUYERS' GUIDE •

As a service to A.F.A. Members and those who use Association media for promoting the usefulness of their products in the Foundry Industry, current AMERICAN FOUNDRYMAN Advertisers and Exhibitors at the 1948 Foundry Show are presented in the Official Convention Issues Buyers' Guide.
Advertisers indicated by asterisk (*).

ABRASIVES (Blasting)

*Alloy Metal Abrasive Co., 311 W. Huron St., Ann Arbor, Mich.
American Steel Abrasives Co., Sherman & East Sts., Galion, Ohio.
*Carpenter Brothers, Inc., 606 W. Wisconsin Ave., Milwaukee 3.
*Cleveland Metal Abrasive Co., 887 E. 67th St., Cleveland.
Globe Steel Abrasive Co., 238 First Ave., Mansfield, Ohio.
Harrison Abrasive Corp., P.O. Box 290, Elizabeth, N.J.
*Ottawa Silica Co., Box 437, Ottawa, Ill.
*Pangborn Corp., Hagerstown, Md.
*Pennsylvania Foundry Supply & Sand Co., Ashland & E. Lewis Sts., Philadelphia 24.
George Pfaff, Inc., 10-61 Jackson Ave., Long Island City 1, N.Y.
*Pittsburgh Crushed Steel Co., 4839 Harrison St., Pittsburgh 1.

ABRASIVES (Grinding)

*Bay State Abrasive Products Co., Union St., Westboro, Mass.
DoAll Co., 254 N. Laurel Ave., Des Plaines Ill.
*Manhattan Rubber Div., Raybestos-Manhattan, Inc., 61 Willett St., Passaic, N.J.
*Peninsular Grinding Wheel Co., 729 Meldrum Ave., Detroit 7.
George Pfaff, Inc., 10-61 Jackson Ave., Long Island City 1, N.Y.
*Simonds Abrasive Co., Tacony & Fraley Sts., Philadelphia 37.
*Sterling Grinding Wheel Div., Cleveland Quarries Co., Tiffin 3, Ohio.
Tabor Mfg. Co., 6225 Tacony St., Philadelphia 35.

ACETYLENE

Air Reduction Sales Co., 42nd St., opposite Grand Central, New York 17.
Linde Air Products Co., 30 E. 42nd St., New York 17.

AERATORS

*Jeffrey Mfg. Co., 977 N. 4th St., Columbus 16.
Newaygo Engineering Co., Newaygo, Mich.
Standard Sand & Machine Co., 549 W. Washington Blvd., Chicago 6.

AFTER-COOLERS

*Ingersoll-Rand Co., 11 Broadway, New York 4.
*Jas. A. Murphy & Co., 5th & Vine Sts., Hamilton, Ohio.
*Nichols Engineering & Research Corp., 60 Wall Tower, New York.

AIR COMPRESSORS

Allis-Chalmers Mfg. Co., 1126 S. 70th St., Milwaukee 1.
Chicago Pneumatic Tool Co., 6 E. 44th St., New York 17.
Davey Compressor Co., Maple & Walnut Sts., Kent, Ohio.
*Ingersoll-Rand Co., 11 Broadway, New York 4.
*Schramm, Inc., West Chester, Pa.
*U.S. Hoffman Machinery Corp., 99 Fourth Ave., New York 3.

AIR LINE ACCESSORIES

Dallett Co., Mascher at Lippincott St., Philadelphia 33.
*Jas. A. Murphy & Co., 5th & Vine Sts., Hamilton, Ohio.
A. Schraders Son, Div. of Scovill Mfg. Co., Inc., 470 Vanderbilt Ave., Brooklyn 17, N.Y.

AIR PURIFIERS

*American Air Filter Co., Inc., 215 Central Ave., Louisville.

AIR SEPARATORS

*Jas A. Murphy & Co., 5th & Vine Sts., Hamilton, Ohio.

ALLOYS (Aluminum & Magnesium)

*Apex Smelting Co., 2537 W. Taylor St., Chicago 12; 6700 Grand Ave., Cleveland 5.

ALLOYS (Ferrous)

*Electro Metallurgical Co., 30 E. 42nd St., New York 17.
*Electro Refractories & Alloys Corp., 344 Delaware Ave., Buffalo, N.Y.
*Niagara Falls Smelting & Refining Div., Continental-United Industries Co., Inc., 2204-14 Elmwood Ave., Buffalo 17, N.Y.
Tennessee Products & Chemical Corp., American National Bank Bldg., Nashville 3.
Vanadium Corp. of America, 420 Lexington Ave., New York 17.

ALLOYS (Non-Ferrous)

*Alter Co., 1701 Rockingham Rd., Davenport, Ia.
*Bohn Aluminum & Brass Corp., Aluminum Refiners Div., 1400 Lafayette Bldg., Detroit 26.
*Bohn Aluminum & Brass Corp., Michigan Smelting & Refining Div., 1400 Lafayette Bldg., Detroit 26.
*Christiansen Corp., 1 N. LaSalle St., Chicago 2.
*City Pattern Foundry & Machine Co., 1161 Harper Ave., Detroit 11.
Colonial Smelting & Refining Co., 2nd & Linden Sts., Columbia, Pa.
*Duquesne Smelting Corp., 50 Thirty-third St., Pittsburgh 1.
*Electro Metallurgical Co., 30 E. 42nd St., New York 17.
*Electro Refractories & Alloys Corp., 344 Delaware Ave., Buffalo, N.Y.
*Federated Metals Div., American Smelting & Refining Co., 120 Broadway, New York 5.
Samuel Greenfield Co., Inc., 31 Stone St., Buffalo, N.Y.
*International Nickel Co., Inc., 67 Wall St., New York 5.
Interstate Smelting & Refining Co., 332 S. Michigan Ave., Chicago.
*H. Kramer & Co., 1345 W. 21st St., Chicago.
*R. Lavin & Sons, Inc., 3426 S. Kedzie Ave., Chicago 23.
Nassau Smelting & Refining Co., Inc., 1 Nassau Place, Tottenville, Staten Island 7, N.Y.
*Niagara Falls Smelting & Refining Div., Continental-United Industries Co., Inc., 2204-14 Elmwood Ave., Buffalo 17, N.Y.
*North American Smelting Co., Edgemont & Tioga Sts., Philadelphia 34.
*Silverstein & Pinsof, Inc., 1720 Elston Ave., Chicago 22.
*U.S. Reduction Co., East Chicago, Ind.
*Hyman Viener & Sons, 5300 Hatcher St., Richmond, Va.
White Bros. Smelting Corp., Richmond & Hedley Sts., Philadelphia 37.

ALLOYS (Special)

*Electro Metallurgical Co., 30 E. 42nd St., New York 17.
*Niagara Falls Smelting & Refining Div., Continental United Industries Co., Inc., 2200-2214 Elmwood Ave., Buffalo 17, N.Y.

BAND SAW MACHINES (Friction Cutting)

Grob Brothers, Grafton, Wis.

BELTING

DoAll Co., 254 N. Laurel Ave., Des Plaines, Ill.
*E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33.
*Manhattan Rubber Div., Raybestos-Manhattan, Inc., 61 Willett St., Passaic, N.J.

BLAST CLEANING EQUIPMENT (Air)

*Alloy Metal Abrasive Co., 311 W. Huron St., Ann Arbor, Mich.
Macleod Co., 2232-40 Bogen St., Cincinnati 22.
*Pangborn Corp., Hagerstown, Md.
*Pittsburgh Crushed Steel Co., 4839 Harrison St., Pittsburgh.
A. Schraders Son, Div. of Scovill Mfg. Co., Inc., 470 Vanderbilt Ave., Brooklyn 17, N.Y.
W. W. Sly Mfg. Co., 4700 Train Ave., Cleveland.

BLAST CLEANING EQUIPMENT (Airless)

*American Wheelabrator & Equipment Corp., South Byrkit, Mishawaka, Ind.
Hydro-Blast Corp., 2550 N. Western Ave., Chicago 47.
*Pangborn Corp., Hagerstown, Md.
*Pittsburgh Crushed Steel Co., 4839 Harrison St., Pittsburgh.

BLAST CLEANING EQUIPMENT (Hydraulic)

Hydro-Blast Corp., 2550 N. Western Ave., Chicago 47.
*Pangborn Corp., Hagerstown, Md.
*Whiting Corp., 15628 Lathrop Ave., Harvey, Ill.

BLOWERS

*Ingersoll-Rand Co., 11 Broadway, New York 4.
Roots-Connersville Blower Corp., 900 W. Mount St., Connersville, Ind.
Spencer Turbine Co., 486 New Park Ave., Hartford 6, Conn.
Standard Electrical Tool Co., 2490 River Road, Cincinnati 4.
Stroman Furnace & Engineering Co., 9900 Franklin Ave., Franklin Park, Ill.
*U.S. Hoffman Machinery Corp., 99 Fourth Ave., New York 3.

BLOW VALVES

Cleveland Vibrator Co., 2828 Clinton Ave., W., Cleveland 13.
*Flex-Rite Valve & Mfg. Co., 118 S. Cheyenne, Tulsa 3.
A. Schraders Son, Div. of Scovill Mfg. Co., Inc., 470 Vanderbilt Ave., Brooklyn 17, N.Y.

BOTTOM BOARDS

*Adams Co., Fourth Street Extention, Dubuque, Ia.
*Christiansen Corp., 1 N. LaSalle St., Chicago 2.
Diamond Clamp & Flask Co., Box 256, Richmond, Ind.
*Dougherty Lumber Co., 4300 E. 68th St., Cleveland.
Industrial Fabricating, Inc., 817 Hall St., Eaton Rapids, Mich.
*Pennsylvania Chaplet Co., Ashland & E. Lewis Sts., Philadelphia 24.
*Sterling Wheelbarrow Co., 7036 W. Walker St., Milwaukee 14.

BRICK (Refractory)

G. & W. H. Corson, Inc., Plymouth Meeting, Pa.; 261 Fabian Pl., Newark, N.J.
*Electro Refractories & Alloys Corp., 344 Delaware Ave., Buffalo, N.Y.
Harbison-Walker Refractories Co., 1800 Farmers Bank Bldg., Pittsburgh 22.
*Illinois Clay Products Co., 608 S. Dearborn St., Chicago 5.
Ironton Fire Brick Co., Box 124, Ironton, Ohio.
Laclede-Christy Clay Products Co., St. Louis, Mo.
Lava Crucible Co. of Pittsburgh, 627 Wabash Bldg., Pittsburgh 22.
*Pyro Refractories Co., Oak Hill, Ohio.
*Quigley Co., Inc., 527 Fifth Ave., New York 17.

BRINELL HARDNESS TESTER (Portable)

Andrew King, Consulting Engineer, 521 Broad Acres Rd., Narberth, Pa.

BRIQUETTING PRESSES

Grob Brothers, Grafton, Wis.
*Milwaukee Foundry Equipment Co., 3238 W. Pierce St., Milwaukee.
*Sklenar Furnace & Mfg. Co., 38 Memorial Dr., Cambridge, Mass.

BUCKETS (Clamshell)

*Blaw-Knox Div., Blaw-Knox Co., Farmers Bank Bldg., Pittsburgh 22.
Harnischfeger Corp., 4400 W. National Ave., Milwaukee 14.

BUCKETS (Elevating)

*Chain Belt Co., 1600 W. Bruce St., Milwaukee 4.
Palmer Bee Co., Detroit 12.
*Pekay Machine & Engineering Co., 100 N. LaSalle St., Chicago 2.

BUFFING AND POLISHING MACHINES

*Mall Tool Co., 7740 South Chicago Ave., Chicago 19.
Pratt & Whitney, Div. Niles Bement Pond Co., Kellerflex Dept., Charter Oak Blvd., West Hartford 1, Conn.
Standard Electrical Tool Co., 2490 River Road, Cincinnati 4.

CASTINGS (Ferrous)

Meehanite Metal Corp., Pershing Sq. Bldg., New Rochelle, N.Y.
*Wheland Co., 2727 S. Broad St., Chattanooga 2, Tenn.

CASTINGS (Non-Ferrous)

*International Nickel Co., 67 Wall St., New York 5.
*Hyman Viener & Sons, 5300 Hatcher St., Richmond, Va.

CEMENT (Refractory)

Alpha-Lux Co., Inc., 155 John St., New York 7.
American Crucible Co., North Haven, Conn.
Bay State Crucible Co., 26 Presby Ct., Taunton, Mass.
Ironton Fire Brick Co., Box 124, Ironton, Ohio.
National Crucible Co., Mermaid Lane & Queen St., Philadelphia 18.
S. Obermayer Co., 2563 W. 18th St., Chicago 8.
Pittsburgh Metals Purifying Co., 1352 Marvista St., Pittsburgh 12.
*Quigley Co., Inc., 527 Fifth Ave., New York 17.
Ramtite Co., Div. S. Obermayer Co., 2563 W. 18th St., Chicago 8.

CENTRIFUGAL CASTING MACHINES

Allis-Chalmers Mfg. Co., 1126 S. 70th St., Milwaukee 1.
Centrifugal Casting Machine Co., Box 947, Tulsa, Okla.
Herman Pneumatic Machine Co., 1806 Union Bank Bldg., Pittsburgh 22.

CERIUM METAL

General Cerium Co., 1038 River Road, Edgewater, N.J.

CHAINS (Industrial)

*Chain Belt Co., 1600 W. Bruce St., Milwaukee 4.
Chisholm-Moore Hoist Corp., Tonawanda, N.Y.
Columbus McKinnon Chain Corp., Tonawanda, N.Y.
Link-Belt Co., 300 W. Pershing Rd., Chicago 9.
*Pekay Machine & Engineering Co., 100 N. La Salle St., Chicago 2.

CHAPLETS AND NAILS

Capewell Mfg. Co., 60 Governor St., Hartford, Conn.
Combined Supply & Equipment Co., Inc., 215 Chandler St., Buffalo 7, N.Y.
*Federal Foundry Supply Co., 4600 E. 71st St., Cleveland 5.
*Pennsylvania Chaplet Co., Ashland & E. Lewis Sts., Philadelphia 24.
Springfield Facing Co., Harrison, N.J.; Willimansett, Mass.
*Standard Horse Nail Corp., New Brighton, Pa.

CHEMICALS

*Mathieson Alkali Works, Inc., 60 E. 42nd St., New York 17.

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Chicago Pneumatic Tool Co., 6 E. 44th St., New York 17.
Cleco Div., Reed Roller Bit Co., P.O. Box 2119, Houston 1, Texas.
Dallett Co., Mascher at Lippincott St., Philadelphia 33.
Dayton Pneumatic Tool Co., 8-10 Norwood Ave., Dayton, Ohio.

CLAY (Bonding)

*Baroid Sales Div., National Lead Co., 830 Ducommun St., Los Angeles 12.
*Carpenter Brothers, Inc., 606 W. Wisconsin Ave., Milwaukee 3.
*Eastern Clay Products, Inc., 223 Main St., Jackson, Ohio.
*Federal Foundry Supply Co., 4600 E. 71st St., Cleveland 5.
*Illinois Clay Products Co., 608 S. Dearborn St., Chicago 5.
*Pyro Refractories Co., Oak Hill, Ohio.
Stoller Chemical Co., 31 N. Summit St., Akron, Ohio.
Whitehead Brothers Co., 324 W. 23rd St., New York 11.
*Wyotana Mining Co., 331 First Federal Bldg., St. Paul 1, Minn.

CLAY (Fire)

G. & W. H. Corson, Inc., Plymouth Meeting, Pa.; 261 Fabian Pl., Newark, N.J.
*Eastern Clay Products, Inc., 223 Main St., Jackson, Ohio.
*Great Lakes Foundry Sand Co., 720 United Artists Bldg., Detroit 26.
*Illinois Clay Products Co., 608 S. Dearborn St., Chicago 5.
Laclede-Christy Clay Products Co., St. Louis, Mo.
National Foundry Sand Co., 2970 W. Grand Blvd., Detroit 2.
New Jersey Silica Sand Co., Box 71, Millville, N.J.
*Pyro Refractories Co., Oak Hill, Ohio.

CLEANING (Surface Treatment)

N. Ransohoff, Inc., 16 E. 72nd St., Cincinnati 16.

COKE (Foundry)

Debevoise-Anderson Co., Inc., New York; Philadelphia; Boston; New Haven, Conn.
*Hickman-Williams & Co., Cleveland; Chicago; Cincinnati; St. Louis; Pittsburgh; Philadelphia; New York; Detroit.
Republic Coal & Coke Co., Willoughby Tower, 8 S. Michigan Ave., Chicago 3.
*Semet-Solvay Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6.
Tennessee Products & Chemical Corp., American National Bank Bldg., Nashville 3.

COKE (Petroleum)

Debevoise-Anderson Co., Inc., New York; Philadelphia; Boston; New Haven, Conn.
Republic Coal & Coke Co., Willoughby Tower, 8 S. Michigan Ave., Chicago 3.

CONVERTERS (Side Blow)

*Whiting Corp., 15628 Lathrop Ave., Harvey, Ill.

CONVEYING AND MATERIALS HANDLING EQUIPMENT

Ajax Flexible Coupling Co., Inc., Cor. English & Portage Sts., Westfield, N.Y.
C. O. Bartlett & Snow Co., 6200 Harvard Ave., Cleveland 5.
Bell Aircraft Corp., P.O. Box 1, Buffalo 5, N.Y.
*Butler Bin Co., Carscoop Div., Waukesha, Wis.
*Chain Belt Co., 1600 W. Bruce St., Milwaukee 4.
Chisholm-Moore Hoist Corp., Tonawanda, N.Y.
Dings Magnetic Separator Co., 4740 McGeogh Ave., Milwaukee.
*Engineering Service, Inc., 610 W. Michigan St., Milwaukee 3.
*Hyster Co., 2902 N.E. Clackamas, Portland, Ore.
*Jeffrey Mfg. Co., 977 N. Fourth St., Columbus 16, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago 9.
*Logan Co., 201 Cabel St., Louisville 6, Ky.
Material Movement Industries, Inc., 9257 Laramie Ave., Skokie, Ill.
Mathews Conveyor Co., Ellwood City, Pa.
*Modern Equipment Co., 360 S. Spring St., Port Washington, Wis.
*National Engineering Co., 549 W. Washington Blvd., Chicago 6.
Newaygo Engineering Co., Newaygo, Mich.
Palmer Bee Co., Detroit 12.
*Pekay Machine & Engineering Co., 100 N. LaSalle St., Chicago 2.
Robins Conveyors Div., Hewitt-Robins, Inc., 270 Passaic Ave., Passaic, N.J.
*Royer Foundry & Machine Co., 158 Pringle St., Kingston, Pa.
*Silent Hoist & Crane Co., Inc., 841-65 Sixty-third St., Brooklyn 20, N.Y.
Standard Conveyor Co., N. St. Paul 9, Minn.
Syntron Co., Homer City, Pa.
*U.S. Reduction Co., East Chicago, Ind.
*Jervis B. Webb Co., 8951 Alpine Ave., Detroit 4.
*Whiting Corp., 15628 Lathrop Ave., Harvey, Ill.
Yale & Towne Mfg. Co., 4530 Tacony St., Philadelphia 24.

CORE AND MOLD WASHES

Bloomsbury Graphite Co., 30 Church St., Bloomsbury, N.J.
Casein Co. of America, Div. of The Borden Co., 350 Madison Ave., New York 17.
*Dayton Oil Co., P.O. Box 851, 1201 E. Monument Ave., Dayton 1.
*Delta Oil Products Co., 6263 N. Cedarburg Rd., Milwaukee 9.
*Federal Foundry Supply Co., 4600 E. 71st St., Cleveland 5.
Harbison-Walker Refractories Co., 1800 Farmers Bank Bldg., Pittsburgh 22.
Hougland & Hardy, Hardy Sand Co., 507 S.E. 2nd St., Evansville, Ind.
Lauhoff Grain Co., Allbond Corebinder Div., Danville, Ill.

J. S. McCormick Co., 25th St. & A. V. RR., Pittsburgh 22.
National Pulverizing Co., Millville, N.J.
S. Obermayer Co., 2563 W. 18th St., Chicago 8.
*Ottawa Silica Co., Box 437, Ottawa, Ill.
*Pennsylvania Foundry Supply & Sand Co., Ashland & E. Lewis Sts., Philadelphia 24.
Ramtite Co., Div. of S. Obermayer Co., 2563 W. 18th St., Chicago 8.
*Smith Facing & Supply Co., 1857 Carter Rd., Cleveland 13.
Smith Oil & Refining Co., Rockford, Ill.
Springfield Facing Co., Harrison, N.J.; Willimansett, Mass.
*Frederic B. Stevens, Inc., 1800 18th St., Detroit 16.
Thiem Products, Inc., 647 W. Virginia St., Milwaukee.
United Oil Mfg. Co., 1429-31 Walnut St., Erie, Pa.
Whitehead Brothers Co., 324 W. 23rd St., New York 11.

CORE BINDERS, OILS AND COMPOUNDS

Casein Co. of America, Div. of The Borden Co., 350 Madison Ave., New York 17.
Certified Core Oil Co., 3308 S. Cicero Ave., Chicago 50.
Corn Products Sales Co., 17 Battery Pl., New York 4.
*Dayton Oil Co., P.O. Box 851, 1201 E. Monument Ave., Dayton 1.
*Delta Oil Products Co., 6263 N. Cedarburg Rd., Milwaukee 9.
*Federal Foundry Supply Co., 4600 E. 71st St., Cleveland 5.
Hercules Powder Co., Inc., Wilmington 99, Del.
Hill & Griffith Co., Cincinnati 4; Birmingham 1; Chicago 50.
*E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33.
*Chas. A. Krause Milling Co., 404 E. State St., Milwaukee.
Lauhoff Grain Co., Allbond Corebinder Div., Danville, Ill.
J. S. McCormick Co., 25th St. & A. V. RR., Pittsburgh 22.
*Pennsylvania Foundry Supply & Sand Co., Ashland & E. Lewis Sts., Philadelphia 24.
*Penola, Inc., 221 N. LaSalle St., Chicago 1.
George F. Pettinos, Inc., 1206 Locust St., Philadelphia 7.
*Smith Facing & Supply Co., 1857 Carter Rd., Cleveland 13.
Smith Oil & Refining Co., Rockford, Ill.
*Werner G. Smith Co., Div. of Archer-Daniels-Midland Co., 2191 W. 110th St., Cleveland 2.
Springfield Facing Co., Harrison, N.J.; Willimansett, Mass.
Stoller Chemical Co., 31 N. Summit St., Akron, Ohio.
*Swan-Finch Oil Corp., R.C.A. Bldg., West, New York 20.
Thiem Products, Inc., 647 W. Virginia St., Milwaukee.
United Oil Mfg. Co., 1429-31 Walnut St., Erie, Pa.
*Velsicol Corp., 330 E. Grand Ave., Chicago 11.

CORE BLOWERS

Champion Foundry & Machine Co., 1316 W. 21st St., Chicago 8.
Wm. Demmler & Bros., Kewanee, Ill.
International Molding Machine Co., P.O. Box 310, LaGrange Park, Ill.
Martin Engineering Co., 704 Rose St., Kewanee, Ill.
*Milwaukee Foundry Equipment Co., 3238 W. Pierce St., Milwaukee, Wis.
Osborn Mfg. Co., 5401 Hamilton Ave., Cleveland 14.
*Plastic Corp. of Chicago, 2444 S. Central Ave., Chicago 50.
Randall Foundry Equipment Corp., 4600 E. 71st St., Newburgh Station, Cleveland 5.
Redford Iron & Equipment Co., 21315 W. McNichols Road, Detroit 19.
*Sklenar Furnace & Mfg. Co., 38 Memorial Dr., Cambridge, Mass.

CORE BOX CLEANER

Casein Co. of America, Div. of The Borden Co., 350 Madison Ave., New York 17.
*Delta Oil Products Co., 6263 N. Cedarburg Rd., Milwaukee 9.
*E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33.
*Smith Facing & Supply Co., 1857 Carter Rd., Cleveland 13.
United Oil Mfg. Co., 1429-31 Walnut St., Erie, Pa.

CORE CONVEYING EQUIPMENT

*Logan Co., 201 Cabel St., Louisville 6, Ky.
Mathews Conveyer Co., Ellwood City, Pa.
Palmer-Bee Co., Detroit 12.
*Sklenar Furnace & Mfg. Co., 38 Memorial Dr., Cambridge, Mass.
*Sterling Wheelbarrow Co., 7036 W. Walker St., Milwaukee 14.
*Jervis B. Webb Co., 8951 Alpine Ave., Detroit 4.

CORE CRUSHERS

*Jeffrey Mfg. Co., 977 N. Fourth St., Columbus 16, Ohio.
Newaygo Engineering Co., Newaygo, Mich.
*Sklenar Furnace & Mfg. Co., 38 Memorial Dr., Cambridge, Mass.

CORE GRINDERS

*Milwaukee Foundry Equipment Co., 3238 W. Pierce St., Milwaukee, Wis.

CORE KNOCKOUT EQUIPMENT

Dayton Pneumatic Tool Co., 8-10 Norwood Ave., Dayton, Ohio.
Hydro-Blast Corp., 2550 N. Western Ave., Chicago 47.
*Pangborn Corp., Hagerstown, Md.
Robins Conveyors Div., Hewitt-Robins Inc., 270 Passaic Ave., Passaic, N.J.

CORE MAKING MACHINES

Arcade Mfg. Div., Rockwell Mfg. Co., 600 E. Vienna Ave., Milwaukee 1.
Champion Foundry & Machine Co., 1316 W. 21st St., Chicago 8.
Crescent Machine Div., Rockwell Mfg. Co., 600 E. Vienna Ave., Milwaukee 1.
Davenport Machine & Foundry Co., 1628-66 W. 4th St., Davenport, Ia.
Delta Mfg. Div., Rockwell Mfg. Co., 600 E. Vienna Ave., Milwaukee 1.
Wm. Demmler & Bros., Kewanee, Ill.
*Federal Foundry Supply Co., 4600 E. 71st St., Cleveland 5.
Herman Pneumatic Machine Co., 1806 Union Bank Bldg., Pittsburgh 22.
International Molding Machine Co., P.O. Box 310, LaGrange Park, Ill.
*Johnston & Jennings Co., 877 Addison Rd., Cleveland.
Randall Foundry Equipment Corp., 4600 E. 71st St., Newburgh Station, Cleveland 5.
*Sklenar Furnace & Mfg. Co., 38 Memorial Dr., Cambridge, Mass.
*Tabor Mfg. Co., 6225 Tacony St., Philadelphia 35.

CORE OVENS

*Carl-Mayer Corp., 3031 Euclid Ave., Cleveland.
*Foundry Equipment Co., 1831 Columbus Rd., Cleveland 13.
Induction Heating Corp., 181 Wythe Ave., Brooklyn 11, N.Y.
*Kirk & Blum Mfg. Co., 2876 Spring Grove Ave., Cincinnati.
*Young Bros. Co. 6500 Mack Ave., Detroit 7.

CORE PASTE

Casein Co. of America, Div. of The Borden Co., 350 Madison Ave., New York 17.
*Eastern Clay Products, Inc., 223 Main St., Jackson, Ohio.
*Federal Foundry Supply Co., 4600 E. 71st St., Cleveland 5.
Hill & Griffith Co., Cincinnati 4; Birmingham 1; Chicago 50.
Lauhoff Grain Co., Allbond Corebinder Div., Danville, Ill.
*Smith Facing & Supply Co., 1857 Carter Rd., Cleveland 13.
Whitehead Brothers Co., 324 W. 23rd St., New York 11.

CORE PLATES

*Christiansen Corp., 1 N. LaSalle St., Chicago 2.
Diamond Clamp & Flask Co., Box 256, Richmond, Ind.
Industrial Fabricating, Inc., 817 Hall St., Eaton Rapids, Mich.
*Sterling Wheelbarrow Co., 7036 W. Walker St., Milwaukee 14.

CORE RACKS

Industrial Fabricating, Inc., 817 Hall St., Eaton Rapids, Mich.
*Kirk & Blum Mfg. Co., 2876 Spring Grove Ave., Cincinnati.

CORE ROD STRAIGHTENERS AND SHEARING MACHINERY

*Alter Co., 1701 Rockingham Rd., Davenport, Ia.
*Federal Foundry Supply Co., 4600 E. 71st St., Cleveland 5.
*Kane & Roach, Inc., Niagara & Shonnard Sts., Syracuse 4, N.Y.
*Pennsylvania Chaplet Co., Ashland & E. Lewis Sts., Philadelphia 24.
Redford Iron & Equipment Co., 21315 W. McNichols Rd., Detroit 19.

CORE ROOM EQUIPMENT

*Beardsley & Piper Co., Div. of Pettibone Mulliken Corp., 2424 N. Cicero Ave., Chicago 39.
Wm. Demmler & Bros., Kewanee, Ill.
*Federal Foundry Supply Co., 4600 E. 71st St., Cleveland 5.
Freeman Supply Co., 1152 E. Broadway, Toledo 5, Ohio.
Randall Foundry Equipment Corp., 4600 E. 71st St., Newburgh Station, Cleveland 5.

CORE SAND RECLAMATION

Hougland & Hardy, Hardy Sand Co., 507 S.E. 2nd St., Evansville, Ind.
Hydro-Blast Corp., 2550 N. Western Ave., Chicago 47.
Lauhoff Grain Co., Allbond Corebinder Div., Danville, Ill.
Manley Sand Co., Rockton, Ill.
*National Engineering Co., 549 W. Washington Blvd., Chicago 6.
*Nichols Engineering & Research Corp., 60 Wall Tower, New York.
*Ottawa Silica Co., Box 437, Ottawa, Ill.
Taggart & Co., 6903 Torresdale Ave., Philadelphia 35.

CORE VENTS

Combined Supply & Equipment Co., Inc., 215 Chandler St., Buffalo 7, N.Y.
Wm. Demmler & Bros., Kewanee, Ill.
P.M.S. Co., 1071 Power Ave., Cleveland 14.
United Compound Co., 328 S. Park Ave., Buffalo, N.Y.

COUPLINGS (Flexible)

Ajax Flexible Coupling Co., Inc., Cor. English & Portage Sts., Westfield, N.Y.

CRANES (Foundry)

Harnischfeger Corp., 4400 W. National Ave., Milwaukee, 14.
*Hyster Co., 2902 N.E. Clackamas, Portland, Ore.
*Modern Equipment Co., 360 S. Spring St., Port Washington, Wis.
*Whiting Corp., 15628 Lathrop Ave., Harvey, Ill.

CRANES (Tractor)

*Hyster Co., 2902 N.E. Clackamas, Portland, Ore.
*Silent Hoist & Crane Co., Inc., 841-865 Sixty-third St., Brooklyn 20, N.Y.

CRUCIBLES

American Crucible Co., North Haven, Conn.
Bay State Crucible Co., 26 Presby Ct., Taunton, Mass.
Joseph Dixon Crucible Co., Jersey City 3, N.J.
Lava Crucible Co. of Pittsburgh, 627 Wabash Bldg., Pittsburgh 22.
National Crucible Co., Mermaid Lane & Queen St., Philadelphia 18.
Randall Foundry Equipment Corp., Newburgh Station, Cleveland 5.
Ross-Tacony Crucible Co., Robbins & Milnar Sts., Tacony 1, Pa.
Vesuvius Crucible Co., Swissvale, Pittsburgh 18.

CUPOLA BLOWERS

Allis-Chalmers Mfg. Co., 1126 S. 70th St., Milwaukee 1.
Roots-Connersville Blower Corp., 900 W. Mount St., Connersville, Ind.
Spencer Turbine Co., 486 New Park Ave., Hartford 6, Conn.

CUPOLA CHARGERS

Harnischfeger Corp., 4400 W. National Ave., Milwaukee 14.
*Modern Equipment Co., 360 S. Spring St., Port Washington, Wis.
*Whiting Corp., 15628 Lathrop Ave., Harvey, Ill.

CUPOLA CONTROL EQUIPMENT

Foxboro Co., 36 Neponset Ave., Foxboro, Mass.

CUPOLA DUST COLLECTORS

*Claude B. Schneible Co., 2827 - 25th St., Detroit.

CUPOLA LIGHTING TORCHES

Macleod Co., 2232-40 Bogen St., Cincinnati 22.

CUPOLAS

*Modern Equipment Co., 360 S. Spring St., Port Washington, Wis.
*Tabor Mfg. Co., 6225 Tacony St., Philadelphia 35.
*Whiting Corp., 15628 Lathrop Ave., Harvey, Ill.

CUTOFF MACHINES

DoAll Co., 254 N. Laurel Ave., Des Plaines, Ill.
Grob Brothers, Grafton, Wis.
*Kane & Roach, Inc., Niagara & Shonnard Sts., Syracuse 4, N.Y.
*Oliver Machinery Co., 1025 Clancy Ave., Grand Rapids 2, Mich.

DIES

Bullard Gage Co., 17168 Redford Ave., Detroit 19.

DUST COLLECTING EQUIPMENT (Dry)

*Alloy Metal Abrasive Co., 311 W. Huron St., Ann Arbor, Mich.
*American Air Filter Co., Inc., 215 Central Ave., Louisville, Ky.
*American Wheelabrator & Equipment Corp., 630 S. Byrkit St., Mishawaka, Ind.
Johnson-March Corp., Drexel Bldg., Philadelphia 6.
*Kirk & Blum Mfg. Co., 2876 Spring Grove Ave., Cincinnati.
Macleod Co., 2232-40 Bogen St., Cincinnati 22.
*Pangborn Corp., Hagerstown, Md.
W. W. Sly Mfg. Co., 4700 Train Ave., Cleveland.
Standard Electrical Tool Co., 2490 River Rd., Cincinnati 4.
*U.S. Hoffman Machinery Corp., 99 Fourth Ave., New York 3.

DUST COLLECTING EQUIPMENT (Wet)

*American Air Filter Co., Inc., 215 Central Ave., Louisville, Ky.
C. O. Bartlett & Snow Co., 6200 Harvard Ave., Cleveland 5.
*Kirk & Blum Mfg. Co., 2876 Spring Grove Ave., Cincinnati.
*Claude B. Schneible Co., 2827 - 25th St., Detroit, Mich.
*Tabor Mfg. Co., 6225 Tacony St., Philadelphia 35.
*Whiting Corp., 15628 Lathrop Ave., Harvey, Ill.

ELECTRODES

Air Reduction Sales Co., 42nd St., opposite Grand Central, New York 17.
Arcos Corp., 1515 Locust St., Philadelphia 2.
International Graphite & Electrode Corp., St. Marys, Pa.
*International Nickel Co., Inc., 67 Wall St., New York 5.
*National Carbon Co., Inc., 30 E. 42nd St., New York 17.

ENGINEERING SERVICE (Foundry)

Ajax Engineering Corp., Lalor & Hancock Sts., Trenton, N.J.
*Engineering Service, Inc., 610 W. Michigan St., Milwaukee 3.
Fellows Corp., 1012 N. Third St., Milwaukee 3.
*Charles C. Kawin Co., 431 Dearborn St., Chicago 5; 110 Pearl St., Buffalo 2, N.Y.
*Lester B. Knight & Associates, 600 W. Jackson Blvd., Chicago.
Ottes E. Paris, Fdry. Ind. Engr., 111 W. Jackson Blvd., Chicago.
*Pekay Machine & Engineering Co., 100 N. LaSalle St., Chicago 2.
Standard Sand & Machine Co., 549 W. Washington Blvd., Chicago 6.
*U.S. Reduction Co., East Chicago, Ind.
*Whitehead, Sanger & Hoidge, 36 W. 40th St., New York 18.

EXOTHERMIC MATERIALS (Anti-piping Compounds)

National Pigment Co., 2117 E. York St., Milville, N.J.

EXOTHERMIC MATERIALS (Pipe Eliminators)

Exomet, Inc., Conneaut, Ohio.

FACINGS (Foundry)

Asbury Graphite Mills, Inc., Asbury, N.J.
Bloomsbury Graphite Co., 30 Church St., Bloomsbury, N.J.
*Delta Oil Products Co., 6263 N. Cedarburg Rd., Milwaukee 9.
Joseph Dixon Crucible Co., Jersey City 3, N.J.
*Federal Foundry Supply Co., 4600 E. 71st St., Cleveland 5.
Harbison-Walker Refractories Co., 1800 Farmers Bank Bldg., Pittsburgh 22.
Hill & Griffith Co., Cincinnati 4; Birmingham 1; Chicago 50.
J. S. McCormick Co., 25th St. & A. V. RR., Pittsburgh 22.
S. Obermayer Co., 2563 W. 18th St., Chicago 8.
Penn-Rillton Co., 324 W. 23rd St., New York 11.
George F. Pettinos, Inc., 1206 Locust St., Philadelphia 7.
Ramtite Co., Div. of S. Obermayer Co., 2563 W. 18th St., Chicago 8.
*Smith Facing & Supply Co., 1857 Carter Rd., Cleveland 13.
Springfield Facing Co., Harrison, N.J.; Wilimansett, Mass.
*Frederic B. Stevens, Inc., 1800 18th St., Detroit 16.
Stoller Chemical Co., 31 N. Summit St., Akron, Ohio.
Thiem Products, Inc., 674 W. Virginia St., Milwaukee.
United States Graphite Co., 1621 Holland Ave., Saginaw, Mich.
Whitehead Brothers Co., 324 W. 23rd St., New York 11.

FERRO-ALLOYS

*Climax Molybdenum Co., 500 Fifth Ave., New York 18.
Exothermic Alloys Sales & Service, Inc., 301 E. 138th St., Chicago 27.
*Hickman, Williams & Co., Cleveland; Chicago; Cincinnati; St. Louis; Pittsburgh; Philadelphia; New York; Detroit.

FIRE BRICK

G. & W. H. Corson, Inc., Plymouth Meeting, Pa.; 261 Fabian Pl., Newark, N.J.
Delhi Foundry Sand Co., 6326 River Road, Cincinnati 33.
Harbison-Walker Refractories Co., 1800 Farmers Bank Bldg., Pittsburgh 22.
*Illinois Clay Products Co., 608 S. Dearborn St., Chicago 5.
Ironton Fire Brick Co., Box 124, Ironton, Ohio.
Laclede-Christy Clay Products Co., St. Louis, Mo.
*Pyro Refractories Co., Oak Hill, Ohio.
*Quigley Co., Inc., 527 Fifth Ave., New York 17.

FLASK LUMBER

*Dougherty Lumber Co., 4300 E. 68th St., Cleveland.

FLASKS (Aluminum)

*Adams Co., Fourth Street Extension, Dubuque, Ia.
Hines Flask Co., 3431 W. 140th St., Cleveland 11.

FLASKS (Magnesium)

Fremont Flask Co., 1000 Wolfe Ave., Fremont, Ohio.

FLASKS (Steel)

Hines Flask Co., 3431 W. 140th St., Cleveland 11.
Industrial Fabricating, Inc., 817 Hall St., Eaton Rapids, Mich.
*Sterling Wheelbarrow Co., 7036 W. Walker St., Milwaukee 14.

FLASKS (Wood)

*Adams Co., Fourth Street Extension, Dubuque, Ia.
Arcade Mfg. Div., Rockwell Mfg. Co., 600 E. Vienna Ave., Milwaukee 1.
Crescent Machine Div., Rockwell Mfg. Co., 600 E. Vienna Ave., Milwaukee 1.
Delta Mfg. Div., Rockwell Mfg. Co., 600 E. Vienna Ave., Milwaukee 1.
Diamond Clamp & Flask Co., Box 256, Richmond, Ind.
*Dougherty Lumber Co., 4300 E. 68th St., Cleveland.

FLASK TRIMMING AND JACKETS

*Adams Co., Fourth Street Extension, Dubuque, Ia.
Arcade Mfg. Div., Rockwell Mfg. Co., 600 E. Vienna Ave., Milwaukee 1.
Crescent Machine Div., Rockwell Mfg. Co., 600 E. Vienna Ave., Milwaukee 1.
Delta Mfg. Div., Rockwell Mfg. Co., 600 E. Vienna Ave., Milwaukee 1.
Diamond Clamp & Flask Co., Box 256, Richmond, Ind.
Hines Flask Co., 3431 W. 140th St., Cleveland 11.
Industrial Fabricating, Inc., 817 Hall St., Eaton Rapids, Mich.
S. Obermayer Co., 2563 W. 18th St., Chicago 8.
George F. Pettinos, Inc., 1206 Locust St., Philadelphia 7.
Ramtite Co., Div. of S. Obermayer Co., 2563 W. 18th St., Chicago 8.

FLEXIBLE SHAFT EQUIPMENT

*Mall Tool Co., 7740 South Chicago Ave., Chicago 19.
Martindale Electric Co., 1349 Hird Ave., Cleveland 7.
Pratt & Whitney, Div. Niles Bement Pond Co., Kellerflex Dept., Charter Oak Blvd., West Hartford 1, Conn.

FLUORSPAR

Delhi Foundry Sand Co., 6326 River Road, Cincinnati 33.

FLUXES (Aluminum)

*Apex Smelting Co., 2537 W. Taylor St., Chicago 12; 6700 Grant Ave., Cleveland 5.
*Niagara Falls Smelting & Refining Div., Continental United Industries Co., Inc., 2200-14 Elmwood Ave., Buffalo 17, N.Y.

FLUXES (Cupola)

*Cleveland Flux Co., 1026-36 Main Ave., N.W., Cleveland 13.
*Mathieson Alkali Works, Inc., 60 E. 42nd St., New York 17.
Pittsburgh Metals Purifying Co., 1352 Marvista St., Pittsburgh 12.
Thiem Products, Inc., 647 W. Virginia St., Milwaukee.

FLUXES (Non-Ferrous)

*Cleveland Flux Co., 1026-36 Main Ave., N.W., Cleveland 13.
*Mathieson Alkali Works, Inc., 60 E. 42nd St., New York 17.
*Niagara Falls Smelting & Refining Div., Continental-United Industries Co., Inc., 2204-14 Elmwood Ave., Buffalo 17, N.Y.
Pittsburgh Metals Purifying Co., 1352 Marvista St., Pittsburgh 12.
Thiem Products, Inc., 647 W. Virginia St., Milwaukee.
*U.S. Reduction Co., East Chicago, Ind.
*Hyman Viener & Sons, 5300 Hatcher St., Richmond, Va.

FLUXES (Welding)

Air Reduction Sales Co., 42nd St., opposite Grand Central, New York 17.
Linde Air Products Co., 30 E. 42nd St., New York 17.
Pittsburgh Metals Purifying Co., 1352 Marvista St., Pittsburgh 12.

FOUNDRY SUPPLIES (General)

*Alter Co., 1701 Rockingham Rd., Davenport, Ia.
*Cleveland Flux Co., 1026-36 Main Ave., N.W., Cleveland 13.
Combined Supply & Equipment Co., Inc., 215 Chandler St., Buffalo 7, N.Y.
*Federal Foundry Supply Co., 4600 E. 71st St., Cleveland 5.
*General Handle Co., Rice Lake, Wis.
Hill & Griffith Co., Cincinnati 4; Birmingham 1; Chicago 50.
J. S. McCormick Co., 25th St. & A. V. RR., Pittsburgh 22.
S. Obermayer Co., 2563 W. 18th St., Chicago 8.
*Pennsylvania Chaplet Co., Ashland & E. Lewis Sts., Philadelphia 24.
Ramtite Co., Div. of S. Obermayer Co., 2563 W. 18th St., Chicago 8.
Springfield Facing Co., Harrison, N.J.; Wilimansett, Mass.
*Frederic B. Stevens, Inc., 1800 18th St., Detroit 16.
*Jervis B. Webb Co., 8951 Alpine Ave., Detroit 4.

FURNACE LININGS

Ajax Electrothermic Corp., Ajax Park, Trenton 5, N.J.
Alpha-Lux Co., Inc., 155 John St., New York 7.
American Crucible Co., North Haven, Conn.
Bay State Crucible Co., 26 Presby Ct., Taunton, Mass.
Campbell-Hausfeld Co., 300-320 Moore St., Harrison, Ohio.

Harbison-Walker Refractories Co., 1800 Farmers Bank Bldg., Pittsburgh 22.
Lava Crucible Co. of Pittsburgh, 627 Wabash Bldg., Pittsburgh 22.
*National Carbon Co., 30 E. 42nd St., New York 17.
National Crucible Co., Mermaid Lane & Queen St., Philadelphia 18.
Stroman Furnace & Engineering Co., 9900 Franklin Ave., Franklin Park, Ill.

FURNACES (Aluminum and Magnesium Melting)

Ajax Electrothermic Corp., Ajax Park, Trenton, N.J.
Ajax Engineering Corp., Lalor & Hancock Sts., Trenton, N.J.
*Ajax Metal Co., 46 Richmond St., Philadelphia 23.
Campbell-Hausfeld Co., 300-320 Moore St., Harrison, Ohio.
*Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12.
Randall Foundry Equipment Corp., 4600 E. 71st St., Newburgh Station, Cleveland 5.
*Sklenar Furnace & Mfg. Co., 38 Memorial Dr., Cambridge, Mass.
Stroman Furnace & Engineering Co., 9900 Franklin Ave., Franklin Park, Ill.

FURNACES (Crucible)

Ajax Electrothermic Corp., Ajax Park, Trenton 5, N.J.
Campbell-Hausfeld Co., 300-320 Moore St., Harrison, Ohio.
*Carl-Mayer Corp., 3031 Euclid Ave., Cleveland
*Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12.
Randall Foundry Equipment Corp., 4600 E. 71st St., Newburgh Station, Cleveland 5.
Stroman Furnace & Engineering Co., 9900 Franklin Ave., Franklin Park, Ill.

FURNACES (Electric)

Ajax Electrothermic Corp., Ajax Park, Trenton 5, N.J.
Ajax Engineering Corp., Lalor & Hancock Sts., Trenton, N.J.
*Ajax Metal Co., 46 Richmond St., Philadelphia 23.
*American Bridge Co., U.S. Steel Corp. Subsidiary, 440 Fifth Ave., Pittsburgh.
*Carl-Mayer Corp., 3031 Euclid Ave., Cleveland
*Despatch Oven Co., 619 S.E. 8th St., Minneapolis.
*Detroit Electric Furnace Div., Kuhlman Electric Co., 1000 26th St., Bay City, Mich.
*Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12.
*Pittsburgh Lectromelt Furnace Corp., Foot of 82nd St., Pittsburgh.
*Salem Engineering Co., Salem, Ohio.
*Whiting Corp., 15628 Lathrop Ave., Harvey, Ill.

FURNACES (Gas or Oil Fired)

Ajax Electrothermic Corp., Ajax Park, Trenton 5, N.J.
Campbell-Hausfeld Co., 300-320 Moore St., Harrison, Ohio.
*Carl-Mayer Corp., 3031 Euclid Ave., Cleveland.
*Despatch Oven Co., 619 S.E. 8th St., Minneapolis.
*Foundry Equipment Co., 1831 Columbus Rd., Cleveland 13.
*Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12.
Randall Foundry Equipment Corp., 4600 E. 71st St., Newburgh Station, Cleveland 5.
*Salem Engineering Co., Salem, Ohio.
*Sklenar Furnace & Mfg. Co., 38 Memorial Dr., Cambridge, Mass.
Stroman Furnace & Engineering Co., 9900 Franklin Ave., Franklin Park, Ill.

FURNACES (Heat Treating)

Ajax Electrothermic Corp., Ajax Park, Trenton 5, N.J.
*Ajax Metal Co., 46 Richmond St., Philadelphia 23.
*Carl-Mayer Corp., 3031 Euclid Ave., Cleveland
*Despatch Oven Co., 619 S.E. 8th St., Minneapolis.
DoAll Co., 254 N. Laurel Ave., Des Plaines, Ill.
*Foundry Equipment Co., 1831 Columbus Rd., Cleveland 13.
*Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12.
*Salem Engineering Co., Salem, Ohio.
*Sklenar Furnace & Mfg. Co., 38 Memorial Dr., Cambridge, Mass.
*Lee Wilson Engineering Co., Inc., 20005 W. Lake Rd., Cleveland 16.

GAGES

Bullard Gage Co., 17168 Redford Ave., Detroit 19.

GOGGLES

Air Reduction Sales Co., 42nd St., opposite Grand Central, New York 17.
American Optical Co., 14 Mechanic St., Southbridge, Mass.
Clersite Co., 2508 W. Van Buren St. Chicago 12.
Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh 8.
Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn 1, N.Y.
Safety Clothing & Equipment Co., 7016 Euclid Ave., Cleveland.

GRAPHITE PRODUCTS

American Crucible Co., North Haven, Conn.
Asbury Graphite Mills, Inc., Asbury, N.J.
Bloomsbury Graphite Co., 30 Church St., Bloomsbury, N.J.
Joseph Dixon Crucible Co., Jersey City 3, N.J.
*Federal Foundry Supply Co., 4600 E. 71st St., Cleveland 5.
International Graphite & Electrode Corp., St. Marys, Pa.
Lava Crucible Co. of Pittsburgh, 627 Wabash Bldg., Pittsburgh 22.
*National Carbon Co., Inc., 30 E. 42nd St., New York 17.
National Crucible Co., Mermaid Lane & Queen St., Philadelphia 18.
George F. Pettinos, Inc., 1206 Locust St., Philadelphia 7.
*Smith Facing & Supply Co., 1857 Carter Rd., Cleveland 13.
Stoller Chemical Co., 31 N. Summit St., Akron, Ohio.
United States Graphite Co., 1621 Holland Ave., Saginaw, Mich.
Vesuvius Crucible Co., Swissvale, Pittsburgh 18.

GRAPHITE STOPPER HEADS

Joseph Dixon Crucible Co., Jersey City 3, N.J.
*National Carbon Co., Inc., 30 E. 42nd St., New York 17.
Ross-Tacony Crucible Co., Robbins & Milnar Sts., Tacony 1, Pa.
Vesuvius Crucible Co., Swissvale, Pittsburgh 18.

GRINDERS (Electric)

Buckeye Tools Corp., 29 W. Apple St., Dayton, Ohio.
Chicago Pneumatic Tool Co., 6 E. 44th St., New York 17.
DoAll Co., 254 N. Laurel Ave., Des Plaines, Ill.
Fox Grinders, Inc., 622 Oliver Bldg., Pittsburgh 22.
*Mall Tool Co., 7740 South Chicago Ave., Chicago 19.
Standard Electrical Tool Co., 2490 River Rd., Cincinnati 4.
Syntron Co., Homer City, Pa.

GRINDERS (Flexible Shaft)

*Mall Tool Co., 7740 South Chicago Ave., Chicago 19.
Martindale Electric Co., 1349 Hird Ave., Cleveland 7.
Pratt & Whitney, Div. Niles Bement Pond Co., Kellerflex Dept., Charter Oak Blvd., West Hartford 1, Conn.

GRINDERS (Pneumatic)

Buckeye Tools Corp., 29 W. Apple St., Dayton, Ohio.
Chicago Pneumatic Tool Co., 6 E. 44th St., New York 17.
Cleco Div., Reed Roller Bit Co., P.O. Box 2119, Houston 1, Texas.
Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago.
Master Pneumatic Tool Co., Inc., Orwell, Ohio.
Rotor Tool Co., 17325 Euclid Ave., Cleveland 12.

GRINDERS (Swing Frame)

Fox Grinders, Inc., 622 Oliver Bldg., Pittsburgh 22.

GRINDING WHEELS

*Bay State Abrasive Products Co., Union St., Westboro, Mass.
DoAll Co., 254 N. Laurel Ave., Des Plaines, Ill.
*Electro Refractories & Alloys Corp., 344 Delaware Ave., Buffalo, N.Y.
*Manhattan Rubber Div., Raybestos-Manhattan, Inc., 61 Willett St., Passaic, N.J.
*Peninsular Grinding Wheel Co., 729 Meldrum Ave., Detroit 7.
George Pfaff, Inc., 10-61 Jackson Ave., Long Island City 1, N.Y.
Precision Grinding Wheel Co. Inc., 8301 Torresdale Ave., Philadelphia 36.
*Simonds Abrasive Co., Tacony & Fraley Sts., Philadelphia 37.
*Sterling Grinding Wheel Div., Cleveland Quarries Co., Tiffin 3, Ohio.
United States Rubber Co., 1230 Ave. of the Americas, New York.

HAMMERS (Pneumatic)

Cleco Div., Reed Roller Bit Co., P.O. Box 2119, Houston 1, Texas.
Dallett Co., Mascher at Lippincott St., Philadelphia 33.
Dayton Pneumatic Tool Co., 8-10 Norwood Ave., Dayton, Ohio.
Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago.
Master Pneumatic Tool Co., Inc., Orwell, Ohio.
Rotor Tool Co., 17325 Euclid Ave., Cleveland 12.
*Schramm, Inc., West Chester, Pa.

HEATERS (Air)

*Despatch Oven Co., 619 S.E. 8th St., Minneapolis.

HEATERS (Ladle and Mold)

Macleod Co., 2232-40 Bogen St., Cincinnati 22.

HELMETS (Blasting)

*Alloy Metal Abrasive Co., 311 W. Huron St., Ann Arbor, Mich.
American Optical Co., 14 Mechanic St., Southbridge, Mass.
Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh 8.
*Pangborn Corp., Hagerstown, Md.
Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn 1, N.Y.
Safety Clothing & Equipment Co., 7016 Euclid Ave., Cleveland.
W. W. Sly Mfg. Co., 4700 Train Ave., Cleveland.

HELMETS (Welding)

American Optical Co., 14 Mechanic St., Southbridge, Mass.
Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh 8.
Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn 1, N.Y.
Safety Clothing & Equipment Co., 7016 Euclid Ave., Cleveland.

HOISTS (Chain or Electric)

Chisholm-Moore Hoist Corp., Tonawanda, N.Y.
Harnischfeger Corp., 4400 W. National Ave., Milwaukee 14.
*Whiting Corp., 15628 Lathrop Ave., Harvey, Ill.

HOISTS (Mobile)

*Hyster Co., 2902 N.E. Clackamas, Portland, Ore.
Yale & Towne Mfg. Co., 4530 Tacony St., Philadelphia 24.

HOISTS (Pneumatic)

Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago.
*Ingersoll-Rand Co., 11 Broadway, New York 4.

HOSE (Oxygen and Acetylene)

Air Reduction Sales Co., 42nd St., opposite Grand Central, New York 17.
*Manhattan Rubber Div., Raybestos-Manhattan, Inc., 61 Willett St., Passaic, N.J.
United States Rubber Co., 1230 Ave. of the Americas, New York.

HOSE (Pneumatic)

*Manhattan Rubber Div., Raybestos-Manhattan, Inc., 61 Willet St., Passaic, N.J.
A. Schraders Son, Div. of Scovill Mfg. Co., Inc., 470 Vanderbilt Ave., Brooklyn 17, N.Y.
United States Rubber Co., 1230 Ave. of the Americas, New York.

INGOTS (Aluminum Alloy)

*Alter Co., 1701 Rockingham Rd., Davenport, Ia.
*Apex Smelting Co., 2537 W. Taylor St., Chicago 12; 6700 Grant Ave., Cleveland 5.
*Bohn Aluminum & Brass Corp., Aluminum Refiners Div., 1400 Lafayette Bldg., Detroit 26.
*Christiansen Corp., 1 N. LaSalle St., Chicago 2.
Colonial Smelting & Refining Co., 2nd & Linden Sts., Columbia, Pa.
*Federated Metals Div., American Smelting & Refining Co., 120 Broadway, New York 5.

*R. Lavin & Sons, Inc., 3426 S. Kedzie Ave., Chicago 23.
*Niagara Falls Smelting & Refining Div., Continental-United Industries Co., Inc., 2204-14 Elmwood Ave., Buffalo 17, N.Y.
*North American Smelting Co., Edgemont & Tioga Sts., Philadelphia 34.
*Silverstein & Pinsof, Inc., 1720 Elston Ave., Chicago 22.
*U.S. Reduction Co., East Chicago, Ind.

INGOTS (Non-Ferrous)

*Ajax Metal Co., 46 Richmond St., Philadelphia 23.
*Bohn Aluminum & Brass Corp., Aluminum Refiners Div., 1400 Lafayette Bldg., Detroit 26.
*Bohn Aluminum & Brass Corp., Michigan Smelting & Refining Div., 1400 Lafayette Bldg., Detroit 26.
*Christiansen Corp., 1 N. LaSalle St., Chicago 2.
Colonial Smelting & Refining Co., 2nd & Linden Sts., Columbia, Pa.
*Duquesne Smelting Corp., 50 Thirty-third St., Pittsburgh 1.
*Federated Metals Div., American Smelting & Refining Co., 120 Broadway, New York 5.
Samuel Greenfield Co., Inc., 31 Stone St., Buffalo, N.Y.
*Benj. Harris & Co., Chicago Heights, Ill.
*Interstate Smelting & Refining Co., 332 S. Michigan Ave., Chicago.
*R. Lavin & Sons, Inc., 3426 S. Kedzie Ave., Chicago 23.
Nassau Smelting & Refining Co., Inc., 1 Nassau Pl., Tottenville, Staten Island 7, N.Y.
*Niagara Falls Smelting & Refining Div., Continental-United Industries Co., Inc., 2204-14 Elmwood Ave., Buffalo 17, N.Y.
*North American Smelting Co., Edgemont & Tioga Sts., Philadelphia 34.
*Silverstein & Pinsof, Inc., 1720 Elston Ave., Chicago 22.
White Bros. Smelting Corp., Richmond & Hedley Sts., Philadelphia 37.

INSULATION

Lava Crucible Co. of Pittsburgh, 627 Wabash Bldg., Pittsburgh 22.
*Quigley Co., Inc., 527 Fifth Ave., New York 17.

IRON OXIDE

*Tamms Silica Co., 228 N. LaSalle St., Chicago 1.

LABORATORY AND SCIENTIFIC EQUIPMENT

*Buehler, Ltd., 165 W. Wacker Dr., Chicago 1.
*Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4.
*Great Western Mfg. Co., 208 Choctaw, Leavenworth, Kan.
Illinois Testing Laboratories, Inc., 420 N. LaSalle St., Chicago 10.
Andrew King, Consulting Engineer, 521 Broad Acres Rd., Narberth, Pa.
*Wilkens-Anderson Co., 111 N. Canal St., Chicago 6.

LABORATORY SERVICE

*Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4.
*Charles C. Kawin Co., 431 S. Dearborn St., Chicago 5; 110 Pearl St., Buffalo 2, N.Y.
Metlab Co., 1000 E. Mermaid Lane, Philadelphia.

LADLE LININGS (Fitted)

Harbison-Walker Refractories Co., 1800 Farmers Bank Bldg., Pittsburgh 22.
Lava Crucible Co. of Pittsburgh, 627 Wabash Bldg., Pittsburgh 22.

LADLE LININGS (Plastic)

Alpha-Lux Co., Inc., 155 John St., New York 7.
G. & W. H. Corson, Inc., Plymouth Meeting, Pa.; 261 Fabian Pl., Newark, N.J.
Harbison-Walker Refractories Co., 1800 Farmers Bank Bldg., Pittsburgh 22.
Ironton Fire Brick Co., Box 124, Ironton, Ohio.
Laclede-Christy Clay Products Co., St. Louis, Mo.
Lava Crucible Co. of Pittsburgh, 627 Wabash Bldg., Pittsburgh 22.
Pittsburgh Metals Purifying Co., 1352 Marvista St., Pittsburgh 12.

LADLES

*Industrial Equipment Co., 115 N. Ohio St., Minster, Ohio.
*Modern Equipment Co., 360 S. Spring St., Port Washington, Wis.
*Whiting Corp., 15628 Lathrop Ave., Harvey, Ill.

MAGNET CHARGERS

Ready-Power Co., 3826 Grand River Ave., Detroit 8.

MAGNETIC SEPARATORS

Dings Magnetic Separator Co., 4740 McGeogh Ave., Milwaukee.

MAGNETS

Dings Magnetic Separator Co., 4740 McGeogh Ave., Milwaukee.

MAGNETS (Lifting)

Dings Magnetic Separator Co., 4740 McGeogh Ave., Milwaukee.

MATCHPLATES

Accurate Match Plate Co., Inc., 1847 W. Carroll Ave., Chicago 12.
Carlson Pattern Shop, Inc., 616 Berkshire Ave., Springfield 9, Mass.
*City Pattern Foundry & Machine Co., 1161 Harper Ave., Detroit 11.
*Grundy & Svenson, S.W. Cor. Front & Olney Aves., Philadelphia 20.
*Pennsylvania Chaplet Co., Ashland & E. Lewis Sts., Philadelphia 24.
*Plaster Process Castings Co., 6924 Carnegie Ave., Cleveland 3.
*Plastic Corp. of Chicago, 2444 S. Central Ave., Chicago 50.
Pressure Match Plate Co., Inc., 1013-15 N. Front St., Philadelphia 23.
*Scientific Cast Products Corp., 1390 E. 40th St., Cleveland; 2520 W. Lake St., Chicago.

MAULS

*General Handle Co., Rice Lake, Wis.

METALLOGRAPHIC EQUIPMENT

*Buehler, Ltd., 165 W. Wacker Dr., Chicago 1.

METERS (Air Velocity)

Illinois Testing Laboratories, Inc., 420 N. LaSalle St., Chicago 10.

MILLING CUTTERS

Severance Tool Industries Inc., P.O. Box 850, Saginaw, Mich.

MOLD CONVEYORS

C. O. Bartlett & Snow Co., 6200 Harvard Ave., Cleveland 5.
*Chain Belt Co., 1600 W. Bruce St., Milwaukee 4.
*Engineering Service, Inc., 610 W. Michigan St., Milwaukee 3.
*Jeffrey Mfg. Co., 977 N. Fourth St., Columbus 16, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago 9.
*Logan Co., 201 Cabel St., Louisville 6, Ky.
*National Engineering Co., 549 W. Washington Blvd., Chicago 6.
Newaygo Engineering Co., Newaygo, Mich.
Palmer-Bee Co., Detroit 12.
*W. G. Reichert Engineering Co., 1060 Broad St., Newark 2, N.J.
*Sklenar Furnace & Mfg. Co., 38 Memorial Dr., Cambridge, Mass.
Standard Sand & Machine Co., 549 W. Washington Blvd., Chicago 6.
*Jervis B. Webb Co., 8951 Alpine Ave., Detroit 4.

MOLD DRYING TORCHES

*Sklenar Furnace & Mfg. Co., 38 Memorial Dr., Cambridge, Mass.

MOLDING MACHINES

*Adams Co., Fourth Street Extension, Dubuque, Ia.
Arcade Mfg. Div., Rockwell Mfg. Co., 1212 E. Shawnee St., Freeport, Ill.
*Beardsley & Piper Co., Div. Pettibone Mulliken Corp., 2424 N. Cicero Ave., Chicago 39.
Champion Foundry & Machine Co., 1316 W. 21st St., Chicago 8.
Crescent Machine Div., Rockwell Mfg. Co., 600 E. Vienna Ave., Milwaukee 1.
Davenport Machine & Foundry Co., 1628-66 W. 4th St., Davenport, Ia.
Fellows Corp., 1012 N. Third St., Milwaukee 3.
Herman Pneumatic Machine Co., 1806 Union Bank Bldg., Pittsburgh 22.
Hill & Griffith Co., Cincinnati 4; Birmingham 1; Chicago 50.
International Molding Machine Co., P.O. Box 310, LaGrange Park, Ill.
*Johnston & Jennings Co., 877 Addison Rd., Cleveland.
*Milwaukee Foundry Equipment Co., 3238 W. Pierce St., Milwaukee.
Wm. H. Nicholls Co., Inc., 126th St., & 91st Ave., Richmond Hill 18, N.Y.
Osborn Mfg. Co., 5401 Hamilton Ave., Cleveland 14.
*Sklenar Furnace & Mfg. Co., 38 Memorial Dr., Cambridge, Mass.
SPO, Inc., 7500 Grand Division Ave., Cleveland.
*Tabor Mfg. Co., 6225 Tacony St., Philadelphia 35.

MOLD OVENS AND DRYERS

*Carl-Mayer Corp., 3031 Euclid Ave., Cleveland.
*Foundry Equipment Co., 1831 Columbus Rd., Cleveland 13.
*Kirk & Blum Mfg. Co., 2876 Spring Grove Ave., Cincinnati.
*Young Brothers Co., 6500 Mack Ave., Detroit 7.

MONORAIL AND TRAMRAIL SYSTEMS

Chisholm-Moore Hoist Corp., Tonawanda, N.Y.
*W. G. Reichert Engineering Co., 1060 Broad St. Newark 2, N.J.
*Jervis B. Webb Co., 8951 Alpine Ave., Detroit 4.
*Whiting Corp., 15628 Lathrop Ave., Harvey, Ill.

NICKEL AND NICKEL ALLOYS

*International Nickel Co., 67 Wall St., New York 5.
*Niagara Falls Smelting & Refining Div., Continental United Industries Co., Inc., 2200-14 Elmwood Ave., Buffalo 17, N.Y.

OILS (Lubricating)

*Delta Oil Products Co., 6263 N. Cedarburg Rd., Milwaukee 9.
*E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33.
*Penola Inc., 221 N. LaSalle St., Chicago 1.
Smith Oil & Refining Co., Rockford, Ill.
United Oil Mfg. Co., 1429-31 Walnut St., Erie, Pa.

OVENS (Annealing and Heat Treating)

*Despatch Oven Co., 619 S.E. 8th St., Minneapolis.
*Foundry Equipment Co., 1831 Columbus Rd., Cleveland 13.
*Kirk & Blum Mfg. Co., 2876 Spring Grove Ave., Cincinnati.
*Whiting Corp., 15628 Lathrop Ave., Harvey, Ill.
*Young Brothers Co., 6500 Mack Ave., Detroit 7.

OXYGEN

Air Reduction Sales Co., 42nd St., opposite Grand Central, New York 17.
Linde Air Products Co., 30 E. 42nd St., New York 17.

PATTERN COATINGS AND FINISHES

*Kindt-Collins Co., 12651 Elmwood Ave., Cleveland 11.
*McDougall-Butler Co., Inc., 6 Evans St., Buffalo 5.
P.M.S. Co., 1071 Power Ave., Cleveland 14.
Wellman Products Co., 1444 E. 49th St., Cleveland 3.

PATTERN COMPOUND

*Tamms Silica Co., 228 N. LaSalle St., Chicago 1.

PATTERN LUMBER

*Dougherty Lumber Co., 4300 E. 68th St., Cleveland.
*Kindt-Collins Co., 12651 Elmwood Ave., Cleveland 11.

PATTERN PLATES

Carlson Pattern Shop, Inc., 616 Berkshire Ave., Springfield 9, Mass.
Combined Supply & Equipment Co., Inc., 215 Chandler St., Buffalo, N.Y.
*Dougherty Lumber Co., 4300 E. 68th St., Cleveland.
Freeman Supply Co., 1152 E. Broadway, Toledo 5.
*Kindt-Collins Co., 12651 Elmwood Ave., Cleveland 11.
P.M.S. Co., 1071 Power Ave., Cleveland 14.
*Scientific Cast Products Corp., 1390 E. 40th St., Cleveland; 2520 W. Lake St., Chicago.
Wellman Products Co., 1444 E. 49th St., Cleveland 3.

PATTERN PLATES (Plastic)

*Plastic Corp. of Chicago, 2444 S. Central Ave., Chicago 50.

PATTERNS

Carlson Pattern Shop, Inc., 616 Berkshire Ave., Springfield 9, Mass.
*City Pattern Foundry & Machine Co., 1161 Harper Ave., Detroit 11.
*Grundy & Svenson, S.W. Cor. Front & Olney Aves., Philadelphia 20.

PATTERNS (Plastic)

*Plastic Corp. of Chicago, 2444 S. Central Ave., Chicago 50.

PATTERN SHOP EQUIPMENT AND SUPPLIES

Combined Supply & Equipment Co., Inc., 215 Chandler St., Buffalo, N.Y.
DoAll Co., 254 N. Laurel Ave., Des Plaines, Ill.
Freeman Supply Co., 1152 E. Broadway, Toledo 5.
*Kindt-Collins Co., 12651 Elmwood Ave., Cleveland 11.
*Oliver Machinery Co., 1025 Clancy Ave., Grand Rapids 2, Mich.
P.M.S. Co., 1071 Power Ave., Cleveland 14.
Severance Tool Industries, Inc., P.O. Box 850, Saginaw, Mich.
Wellman Products Co., 1444 E. 49th St., Cleveland 3.

PERMANENT MOLDS

Bullard Gage Co., 17168 Redford Ave., Detroit 19.

PHOTOGRAPHIC MATERIALS (Metallography)

*Buehler, Ltd., 165 W. Wacker Dr., Chicago 1.

PIG IRON

Debevoise-Anderson Co., Inc., New York; Philadelphia; Boston; New Haven, Conn.
*Hickman, Williams & Co., Cleveland; Chicago; Cincinnati; St. Louis; Pittsburgh; Philadelphia; New York; Detroit.
*Jackson Iron & Steel Co., Jackson, Ohio.
*Keokuk Electro-Metals Co., Keokuk, Ia.
Tennessee Products & Chemical Corp., American National Bank Bldg., Nashville 3, Tenn.
*Tonawanda Iron Corp., North Tonawanda, N.Y.

PIG IRON (Alloy)

Debevoise-Anderson Co., Inc., New York; Philadelphia; Boston; New Haven, Conn.
*Jackson Iron & Steel Co., Jackson, Ohio.

PLASTER

*Tamms Silica Co., 228 N. LaSalle St., Chicago 1.
*United States Gypsum Co., 300 W. Adams St., Chicago 6.

PNEUMATIC TOOLS

Buckeye Tools Corp., 29 W. Apple St., Dayton, Ohio.
Cleco Div., Reed Roller Bit Co., P.O. Box 2119, Houston 1, Texas.
Dallett Co., Mascher at Lippincott St., Philadelphia 33.
Dayton Pneumatic Tool Co., 8-10 Norwood Ave., Dayton, Ohio.
*Ingersoll-Rand Co., 11 Broadway, New York 4.
Martin Engineering Co., 704 Rose St., Kewanee, Ill.
Master Pneumatic Tool Co., Inc., Orwell, Ohio.
Rotor Tool Co., 17325 Euclid Ave., Cleveland 12.
*Schramm, Inc., West Chester, Pa.

POROSITY EQUIPMENT AND SEALERS

*Tincher Products Co., 1715 W. Lake St., Chicago 12.

PORTABLE TOOLS (Air)

Buckeye Tools Corp., 29 W. Apple St., Dayton, Ohio.
Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago.
*Mall Tool Co., 7740 South Chicago Ave., Chicago 19.
Master Pneumatic Tool Co., Inc., Orwell, Ohio.
Rotor Tool Co., 17325 Euclid Ave., Cleveland 12.
*Schramm, Inc., West Chester, Pa.

PORTABLE TOOLS (Electric)

Buckeye Tools Corp., 29 W. Apple St., Dayton, Ohio.
Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago.
Martindale Electric Co., 1349 Hird Ave., Cleveland 7.
Syntron Co., Homer City, Pa.

POWER UNITS

Ready-Power Co., 3826 Grand River Ave., Detroit 8.

PROTECTIVE COATINGS (Industrial)

*Tousey Varnish Co., 520 W. 25th St., Chicago.

PYROMETERS (Immersion)

Foxboro Co., 36 Neponset Ave., Foxboro, Mass.
Illinois Testing Laboratories, Inc., 420 N. LaSalle St., Chicago 10.
*L. H. Marshall Co., 270 W. Lane Ave., Columbus, Ohio.
*Pyrometer Instrument Co., Inc., Portland & Delford Aves., Bergenfield, N.J.
*Tamms Silica Co., 228 N. LaSalle St., Chicago 1.

PYROMETERS (Optical)

*Buehler, Ltd., 165 W. Wacker Drive, Chicago 1.
*Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4.
*Pyrometer Instrument Co., Inc., Portland & Delford Aves., Bergenfield, N.J.

RADIUM

Radium Chemical Co., Inc., 570 Lexington Ave., New York 22.

RAMMERS (Pneumatic)

Chicago Pneumatic Tool Co., 6 E. 44th St., New York 17.
Cleco Div., Reed Roller Bit Co., P.O. Box 2119, Houston 1, Texas.
Dayton Pneumatic Tool Co., 8-10 Norwood Ave., Dayton, Ohio.
Master Pneumatic Tool Co., Inc., Orwell, Ohio.
Rotor Tool Co., 17325 Euclid Ave., Cleveland 12.

REFRACTORIES

Alpha-Lux Co., Inc., 155 John St., New York 7.
American Crucible Co., North Haven, Conn.
G. & W. H. Corson, Inc., Plymouth Meeting, Pa.; 261 Fabian Pl., Newark, N.J.
Joseph Dixon Crucible Co., Jersey City 3, N.J.
*Eastern Clay Products, Inc., 223 Main St., Jackson, Ohio.
*Electro Refractories & Alloys Corp., 344 Delaware Ave., Buffalo, N.Y.
*Great Lakes Foundry Sand Co., 720 United Artists Bldg., Detroit 26.
*Illinois Clay Products Co., 608 S. Dearborn St., Chicago 5.
Ironton Fire Brick Co., Box 124, Ironton, Ohio.
Laclede-Christy Clay Products Co., St. Louis, Mo.
Lava Crucible Co. of Pittsburgh, 627 Wabash Bldg., Pittsburgh 22.
National Crucible Co., Mermaid Lane & Queen St., Philadelphia 18.
National Foundry Sand Co., 2970 W. Grand Blvd., Detroit 2.
New Jersey Silica Sand Co., Box 71, Millville, N.J.
*Pennsylvania Foundry Supply & Sand Co., Ashland & E. Lewis Sts., Philadelphia 24.
George F. Pettinos, Inc., 1206 Locust St., Philadelphia 7.
*Pyro Refractories Co., Oak Hill, Ohio.
*Quigley Co., Inc., 527 Fifth Ave., New York 17.
Ross-Tacony Crucible Co., Robbins & Milnar Sts. Tacony 1, Pa.
*Frederic B. Stevens, Inc., 1800 18th St., Detroit 16.
Vesuvius Crucible Co., Swissvale, Pittsburgh 18.

RESPIRATORS

American Optical Co., 14 Mechanic St., Southbridge, Mass.
Martindale Electric Co., 1349 Hird Ave., Cleveland 7.
Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh 8.
Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn 1, N.Y.
Safety Clothing & Equipment Co., 7016 Euclid Ave., Cleveland.

RIDDLES AND SCREENS

*Beardsley & Piper Co., Div. Pettibone Mulliken Corp., 2424 N. Cicero Ave., Chicago 39.
Champion Foundry & Machine Co., 1316 W. 21st St., Chicago 8.
*Federal Foundry Supply Co., 4600 E. 71st St., Cleveland 5.
*Great Western Mfg. Co., 208 Choctaw, Leavenworth, Kan.
*Pekay Machine & Engineering Co., 100 N. LaSalle St., Chicago 2.
*Frederic B. Stevens, Inc., 1800 18th St., Detroit 16.

SAFETY CLOTHING AND EQUIPMENT

American Optical Co., 14 Mechanic St., Southbridge, Mass.
Clersite Co., 2508 W. Van Buren St. Chicago 12.
Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh 8.
*Pangborn Corp., Hagerstown, Md.
Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn 1, N.Y.
*Reece Wooden Sole Shoe Co., 2207-11th St., Columbus, Neb.
Safety Clothing & Equipment Co., 7016 Euclid Ave., Cleveland.
*Titan Safety Shoe Co., 212 Essex St., Boston 11, Mass.

SAND (Blast)

*Carpenter Brothers, Inc., 606 W. Wisconsin Ave., Milwaukee 3.
Delhi Foundry Sand Co., 6326 River Road, Cincinnati 33.
*Great Lakes Foundry Sand Co., 720 United Artists Bldg., Detroit 26.
Hougland & Hardy, Hardy Sand Co., 507 S.E. 2nd St., Evansville, Ind.
Manley Sand Co., Rockton, Ill.
National Foundry Sand Co., 2970 W. Grand Blvd., Detroit 2.
National Pulverizing Co., Millville, N.J.
New Jersey Silica Sand Co., Box 71, Millville, N.J.
*Ottawa Silica Co., Box 437, Ottawa, Ill.

SAND (Core and Mold)

Ayers Mineral Co., Zanesville, Ohio.
*Carpenter Brothers, Inc., 606 W. Wisconsin Ave., Milwaukee 3.
Central Silica Co., Zanesville, Ohio.
Delhi Foundry Sand Co., 6326 River Road, Cincinnati 33.
*Great Lakes Foundry Sand Co., 720 United Artists Bldg., Detroit 26.
*Hickman, Williams & Co., Cleveland; Chicago; Cincinnati; St. Louis; Philadelphia; New York; Detroit.
Hougland & Hardy, Hardy Sand Co., 507 S.E. 2nd St., Evansville, Ind.
Lauhoff Grain Co., Allbond Corebinder Div., Danville, Ill.
Manley Sand Co., Rockton, Ill.
Millwood Sand Co., Zanesville, Ohio.
National Foundry Sand Co., 2970 W. Grand Blvd., Detroit 2.
National Pulverizing Co., Millville, N.J.
New Jersey Silica Sand Co., Box 71, Millville, N.J.
*Ottawa Silica Co., Box 437, Ottawa, Ill.
Stoller Chemical Co., 31 N. Summit St., Akron, Ohio.
Taggart & Co., 6903 Torresdale Ave., Philadelphia 35.
Whitehead Brothers Co., 324 W. 23rd St., New York 11.

SAND BLAST EQUIPMENT

*American Wheelabrator & Equipment Corp., 630 S. Byrkit St., Mishawaka, Ind.
Macleod Co., 2232-40 Bogen St., Cincinnati 22.
*Pangborn Corp., Hagerstown, Md.
George Pfaff, Inc., 10-61 Jackson Ave., Long Island City 1, N.Y.
*Pittsburgh Crushed Steel Co., 4839 Harrison St., Pittsburgh.
W. W. Sly Mfg. Co., 4700 Train Ave., Cleveland.

SAND CONTROL AND TESTING EQUIPMENT

Alpha-Lux Co., Inc., 155 John St., New York 7.
*Buehler, Ltd., 165 W. Wacker Dr., Chicago 1.
*Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4.
*Great Western Mfg. Co., 208 Choctaw, Leavenworth, Kan.
Manley Sand Co., Rockton, Ill.

SAND HANDLING AND CONDITIONING EQUIPMENT

Allis-Chalmers Mfg. Co., 1126 S. 70th St., Milwaukee 1.
C. O. Bartlett & Snow Co., 6200 Harvard Ave., Cleveland 5.

*Beardsley & Piper Co., Div., Pettibone Mulliken Corp., 2424 N. Cicero Ave., Chicago 39.
Bell Aircraft Corp., P.O. Box 1, Buffalo 5, N.Y.
*Chain Belt Co., 1600 W. Bruce St., Milwaukee 4.
*Engineering Service, Inc., 610 W. Michigan St., Milwaukee 3.
*Great Western Mfg., Co., 208 Choctaw, Leavenworth, Kan.
Frank G. Hough Co., Libertyville, Ill.
*Jeffrey Mfg. Co., 977 N. Fourth St., Columbus 16, Ohio.
Johnson-March Corp., Drexel Bldg., Philadelphia 6.
Link-Belt Co., 300 W. Pershing Rd., Chicago 9.
Material Movement Industries, Inc., 9257 Laramie Ave., Skokie, Ill.
*Moulders' Friend, Dallas City, Ill.
*National Engineering Co., 549 W. Washington Blvd., Chicago 6.
Newaygo Engineering Co., Newaygo, Mich.
*Nichols Engineering & Research Corp., 60 Wall Tower, New York.
Palmer-Bee Co., Detroit 12.
*Pekay Machine & Engineering Co., 100 N. LaSalle St., Chicago 2.
*W. G. Reichert Engineering Co., 1060 Broad St., Newark 2, N.J.
*Royer Foundry & Machine Co., 158 Pringle St., Kingston, Pa.
Simplicity Engineering Co., Durand, Mich.
*Sklenar Furnace & Mfg. Co., 38 Memorial Dr., Cambridge, Mass.
Standard Sand & Machine Co., 549 W. Washington Blvd., Chicago 6.

SAND MIXERS

*Beardsley & Piper Co., Div. Pettibone Mulliken Corp., 2424 N. Cicero Ave., Chicago 39.
Clearfield Machine Co., Clearfield, Pa.
Freeman Supply Co., 1152 E. Broadway, Toledo 5, Ohio.
*Moulders' Friend, Dallas City, Ill.
*National Engineering Co., 549 W. Washington Blvd., Chicago 6.
Standard Sand & Machine Co., 549 W. Washington Blvd., Chicago 6.

SAND RECLAMATION

*Engineering Service, Inc., 610 W. Michigan St., Milwaukee 3.
Hydro-Blast Corp., 2550 N. Western Ave., Chicago 47.
*Nichols Engineering & Research Corp., 60 Wall Tower, New York.

SAWS (Firebrick)

*Clipper Mfg. Co., 2800 Warwick St., Kansas City 8, Mo.

SAWS (Masonry)

*Clipper Mfg. Co., 2800 Warwick St., Kansas City 8, Mo.

SAWS (Metal Cutting)

Capewell Mfg. Co., 60 Governor St., Hartford, Conn.
DoAll Co., 254 N. Laurel Ave., Des Plaines, Ill.
Grob Brothers, Grafton, Wis.
Martindale Electric Co., 1349 Hird Ave., Cleveland 7.
*Oliver Machinery Co., 1025 Clancy Ave., Grand Rapids 2, Mich.

SAWS (Woodworking)

DoAll Co., 254 N. Laurel Ave., Des Plaines, Ill.
*Oliver Machinery Co., 1025 Clancy Ave., Grand Rapids 2, Mich.

SEPARATORS

Dings Magnetic Separator Co., 4740 McGeogh Ave., Milwaukee.
*Kirk & Blum Mfg. Co., 2876 Spring Grove Ave., Cincinnati.
*Jas. A. Murphy & Co., 5th & Vine Sts., Hamilton, Ohio.
*Royer Foundry & Machine Co., 158 Pringle St., Kingston, Pa.

SHAKE-OUT MACHINERY

Allis-Chalmers Mfg. Co., 1126 S. 70th St., Milwaukee 1.
Cleveland Vibrator Co., 2828 Clinton Ave., W., Cleveland 13.
Herman Pneumatic Machine Co., 1806 Union Bank Bldg., Pittsburgh 22.
Link-Belt Co., 300 W. Pershing Rd., Chicago 9.
Robins Conveyors Div., Hewitt-Robins, Inc., 270 Passaic Ave., Passaic, N.J.
*Royer Foundry & Machine Co., 158 Pringle St., Kingston, Pa.
Simplicity Engineering Co., Durand, Mich.

SHOCK ABSORPTION MATERIALS

Fabreeka Products Co., 222 Summer St., Boston, Mass.

SHOT AND GRIT

*Alloy Metal Abrasive Co., 311 W. Huron St., Ann Arbor, Mich.
American Steel Abrasives Co., Sherman & East Sts., Galion, Ohio.
*American Wheelabrator & Equipment Corp., 630 S. Byrkit St., Mishawaka, Ind.
*Carpenter Brothers, Inc., 606 W. Wisconsin Ave., Milwaukee 3.
*Cleveland Metal Abrasive Co., 887 E. 67th St., Cleveland.
Delhi Foundry Sand Co., 6326 River Rd., Cincinnati 33.
Globe Steel Abrasive Co., 238 First Ave., Mansfield, Ohio.
*Great Lakes Foundry Sand Co., 720 United Artists Bldg., Detroit 26.
*Hickman, Williams & Co., Cleveland; Chicago; Cincinnati; St. Louis; Pittsburgh; Philadelphia; New York; Detroit.
*R. Lavin & Sons, Inc., 3426 S. Kedzie Ave., Chicago 23.
National Foundry Sand Co., 2970 W. Grand Blvd., Detroit 2.
*Pangborn Corp., Hagerstown, Md.
*Pennsylvania Foundry Supply & Sand Co., Ashland & E. Lewis Sts., Philadelphia 24.
George Pfaff, Inc., 10-61 Jackson Ave., Long Island City 1, N.Y.
*Pittsburgh Crushed Steel Co., 4839 Harrison St., Pittsburgh.
*Steel Shot & Grit Co., Boston, Mass.
Steel Shot Producers, Inc., Butler, Pa.
*Hyman Viener & Sons, 5300 Hatcher St., Richmond, Va.

SLINGS (Equalizing)

Chisholm-Moore Hoist Corp., Tonawanda, N.Y.
Columbus McKinnon Chain Corp., Tonawanda, N.Y.

SPECTROGRAPHIC EQUIPMENT AND SUPPLIES

*Eastman Kodak Co., 343 State St., Rochester 4, N.Y.
*National Carbon Co., Inc., 30 E. 42nd St., New York 17.

SPRAYERS

*Jas A. Murphy & Co., 5th & Vine Sts., Hamilton, Ohio.

TEMPERATURE CONTROL AND RECORDING DEVICES

Foxboro Co., 36 Neponset Ave., Foxboro, Mass.
Illinois Testing Laboratories, Inc., 420 N. LaSalle St., Chicago 10.
*L. H. Marshall Co., 270 W. Lane Ave., Columbus, Ohio.
*Pyrometer Instrument Co., Inc., Portland & Delford Aves., Bergenfield, N.J.

THERMOCOUPLES

*Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4.
Foxboro Co., 36 Neponset Ave., Foxboro, Mass.
Illinois Testing Laboratories, Inc., 420 N. LaSalle St., Chicago 10.
*L. H. Marshall Co., 270 W. Lane Ave., Columbus, Ohio.
*Pyrometer Instrument Co., Portland & Delford Aves., Bergenfield, N.J.
*Tamms Silica Co., 228 N. LaSalle St., Chicago 1.

TOTE BOXES AND BARRELS

*Kirk & Blum Mfg. Co., 2876 Spring Grove Ave., Cincinnati.

TRACTORS AND TRUCKS

Bell Aircraft Corp., P.O. Box 1, Buffalo 5, N.Y.

TUMBLING BARRELS (Dry)

*N. Ransohoff, Inc., 16. E. 72nd St., Cincinnati 16.
W. W. Sly Mfg. Co., 4700 Train Ave., Cleveland.
*Whiting Corp., 15628 Lathrop Ave., Harvey, Ill.

TUMBLING BARRELS (Wet)

*N. Ransohoff, Inc., 16 E. 72nd St., Cincinnati 16.
W. W. Sly Mfg. Co., 4700 Train Ave., Cleveland.
*Whiting Corp., 15628 Lathrop Ave., Harvey, Ill.

UNLOADERS (Bulk Material)

*Butler Bin Co., Waukesha, Wis.

VACUUM CLEANING EQUIPMENT

Invincible Vacuum Cleaner Mfg. Co., Inc., 4626-28 Baltimore Ave., Philadelphia 43.
Roots-Connersville Blower Corp., 900 W. Mount St., Connersville, Ind.
Spencer Turbine Co., 486 New Park Ave., Hartford 6, Conn.
*U.S. Hoffman Machinery Corp., 99 Fourth Ave., New York 3.

VENTILATING SYSTEMS

*American Wheelabrator & Equipment Corp., 630 S. Byrkit St., Mishawaka, Ind.
C. O. Bartlett & Snow Co., 6200 Harvard Ave., Cleveland 5.
*Kirk & Blum Mfg. Co., 2876 Spring Grove Ave., Cincinnati.
*Pangborn Corp., Hagerstown, Md.
Powermatic Ventilator Co., 4019 Prospect Ave., Cleveland 3.
*W. G. Reichert Engineering Co., 1060 Broad St., Newark 2, N.J.
H. H. Robertson Co., 2400 Farmers Bank Bldg., Pittsburgh 22.
*Claude B. Schneible Co., 2827 - 25th St., Detroit.

VIBRATORS

Arcade Mfg. Div., Rockwell Mfg. Co., 600 E. Vienna Ave., Milwaukee 1.
Cleveland Vibrator Co., 2828 Clinton Ave., W., Cleveland 13.
Crescent Machine Div., Rockwell Mfg. Co., 600 E. Vienna Ave., Milwaukee 1.
Dallett Co., Mascher at Lippincott St., Philadelphia 33.
Delta Mfg. Div., Rockwell Mfg. Co., 600 E. Vienna Ave., Milwaukee 1.
*Federal Foundry Supply Co., 4600 E. 71st St., Cleveland 5.
Herman Pneumatic Machine Co., 1806 Union Bank Bldg., Pittsburgh 22.
*Johnston & Jennings Co., 877 Addison Rd., Cleveland.
Martin Engineering Co., 704 Rose St., Kewanee, Ill.
SPO, Inc., 7500 Grand Division Ave., Cleveland.
Syntron Co., Homer City, Pa.

WASH ROOM EQUIPMENT

Bradley Washfountain Co., 2203 W. Michigan St., Milwaukee.
*Onox, Inc., 121 Second St., San Francisco 5.

WAX (Vent)

P.M.S. Co., 1071 Power Ave., Cleveland 14.
United Compound Co., 328 S. Park Ave., Buffalo, N.Y.
Wellman Products Co., 1444 E. 49th St., Cleveland 3.

WELDING AND CUTTING EQUIPMENT

Air Reduction Sales Co., 42nd St., opposite Grand Central, New York 17.
Arcos Corp., 1515 Locust St., Philadelphia 2.
DoAll Co., 254 N. Laurel Ave., Des Plaines, Ill.
Harnischfeger Corp., 4400 W. National Ave., Milwaukee 14.
Linde Air Products Co., 30 E. 42nd St., New York 17.

WELDING RODS

Arcos Corp., 1515 Locust St., Philadelphia 2.
*International Nickel Co., Inc., 67 Wall St., New York 5.
Linde Air Products Co., 30 E. 42nd St., New York 17.

WHEELBARROWS

Bell Aircraft Corp., P.O. Box 1, Buffalo 5, N.Y.
*Sterling Wheelbarrow Co., 7036 W. Walker St., Milwaukee 14.

WOODWORKING MACHINERY

Freeman Supply Co., 1152 E. Broadway, Toledo 5, Ohio.
*Kindt-Collins Co., 12651 Elmwood Ave., Cleveland 11.
*Oliver Machinery Co., 1025 Clancy Ave., Grand Rapids 2, Mich.
P.M.S. Co., 1071 Power Ave., Cleveland 14.

X-RAY EQUIPMENT AND SUPPLIES

*Eastman Kodak Co., 343 State St., Rochester 4, N.Y.
*General Electric X-Ray Corp., 4855 W. McGeogh Ave., Milwaukee 14.